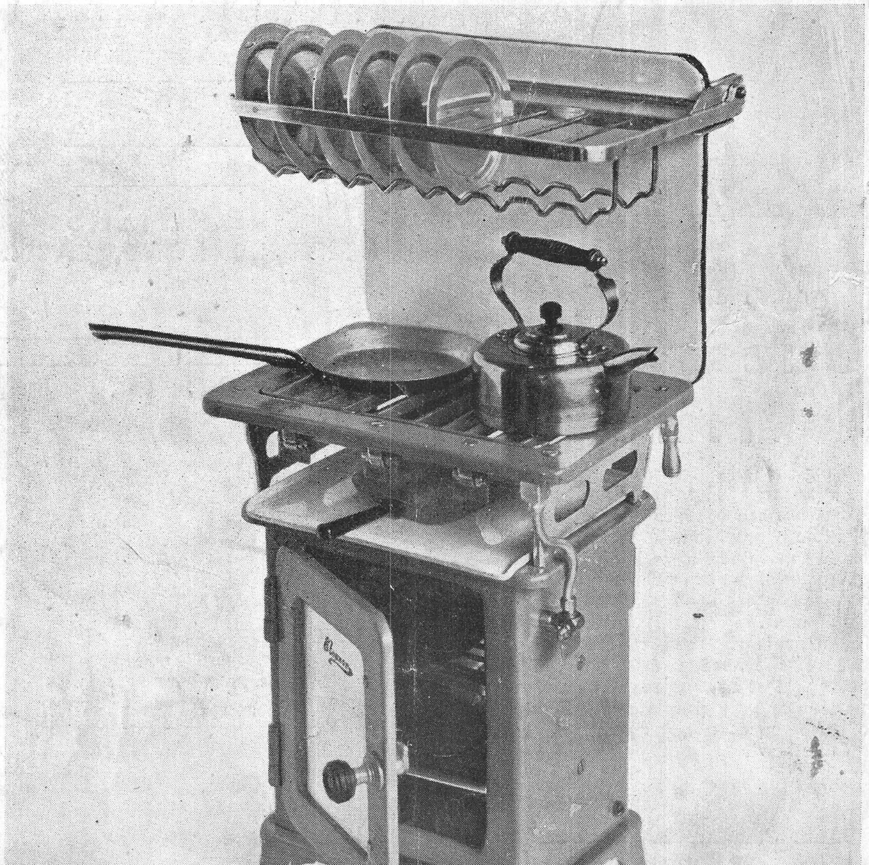
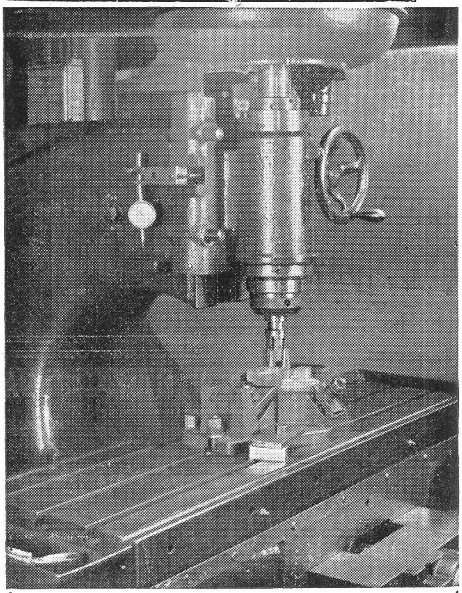
CYLENDERS FOR MASSIE

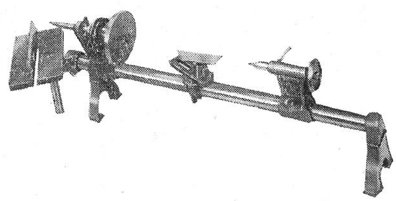
THE MODEL ENGINEER

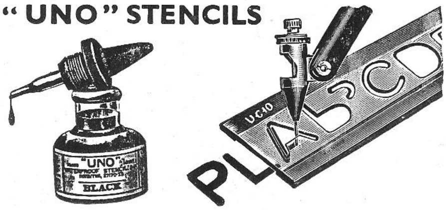
Vol. 94 No. 2350 THURSDAY MAY 23 1946 6d



A one-fifth size working model of a domestic gas cooker, with appropriate details. Made by Mr. T. A. Rosbottom of Hayes, Middlesex







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THE MODEL ENGINEER

MAY 23rd, 1946
VOL. 94. No. 2350

Smoke Rings

The Model Power Boat Association

AT the special general meeting on April 27th it was resolved to re-organise the Association to meet post-war requirements in the development of all types of model power boats. New rules for the competition classification of boats were provisionally adopted, and will be worked out in detail by the committee. In view of inevitable increase in expenditure, affiliation fees were revised, and will now include third party insurance, which is compulsory for all boats run in any form of competition under the auspices of the Association. Activities are to start as soon as possible, and clubs wishing to become affiliated should make early application, to enable full plans, including regatta fixtures, to be prepared without delay. The M.P.B.A. will be represented at THE MODEL ENGINEER Exhibition, and a Grand Regatta for all classes of boats will be held on the Sunday following the Exhibition, (September 1st). The Hon. Secretary is EDGAR T. WESTBURY, 10, Oakhurst Rise, Carshalton Beeches, Surrey.

Motor Car Models

JUDGING from my correspondence there seems to be a growing interest in model motor cars, both for demonstration and racing purposes. Mr. John Jackson, of Selby, offers these comments :—" I must have been a reader of THE MODEL ENGINEER on and off for well over thirty years, and although you have published many very interesting articles on various subjects, I do not think any has given me greater pleasure than Mr. W. Boddy's 'Motor Car Models' in April 11th issue. Very many times I have been surprised that motor-car types apparently interested no one. Quite apart from a model that merely gives an impression of the appearance of a particular type, I have often wondered if any of your readers had ever constructed any of the veteran types incorporating the necessary details of engine and transmission, enabling one to follow exactly the working principles of the design. For instance, the friction drive of the G.W.K., belt drive and twin engine of the G.N. or Buckingham, layout of engine and transmission of the A.V. or Carden monocar, the twin two-stroke, gears and tubular frame construction of the Scott Sociable. It appears to me that the manufacturers themselves have been sadly lacking in not having models produced when an entirely new design is placed on the market." On this last point Mr. Jackson may be interested to know that in *The Motor* there recently appeared some photographs of model cars made by a large concern in the United States as provisional experiments in design and appearance, but not necessarily as standards for production. One photograph shows the chief engineer of the company discussing a group of these models with a colleague. Mr. Jackson makes this further comment :—" Whilst on this subject, a close examination of some of these old cars discloses some remarkably bright ideas and I would go so far as to say that in many cases of designs that eventually were scrapped this would never have happened if modern precision machines and modern steels had been available, and if the roads then had been anything like as good as they are now." By the same post an enquiry reaches me from Switzerland from a reader who is anxious to purchase a model racing car. I give his address in case some of our racing car experts would like to communicate with him. It is :— Georges Zurn, Grand-Val, Av. Maria Belgia, Lausanne.

To Teeside Readers

AN enthusiastic send-off to the new Teeside Model and Experimental Society was accorded by the 46 members who assembled at the recent opening meeting. Two sub-committees were formed to plan suitable arrangements for an outdoor track and for power-boat running, and a programme of fortnightly meetings was discussed. Several good lectures have been promised. Full information may be obtained from Mr. Vincent Byrne, 2, Church Street, Middlesbrough.

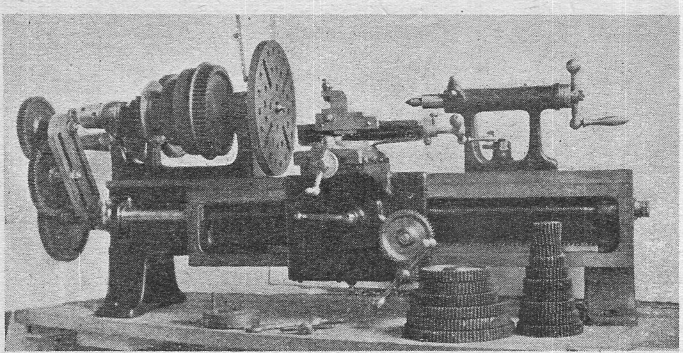
Ship Models on Show

SOME sixty models showing the internal details of ships and their machinery will be a special feature of an exhibition, sponsored by the Worshipful Company of Shipwrights, which is to be held at the Royal Horticultural Hall in January, 1947. The show generally will be intended to illustrate and promote the post-war development of shipbuilding and allied industries. Full information may be obtained from Mr. Walter Pollock, M.I.N.A., at 3, Lloyd's Avenue, London, E.C.3.

Percival Marshall

A 4-in. LATHE & ITS EQUIPMENT

By K. N. HARRIS



THE lathe, illustrated in the accompanying photographs, was acquired (second-hand) as long ago as 1924, and was made by James Spencer of Manchester. Through a variety of circumstances, it received little use until well into the last war, when soon after the formation of the Home Guard, it was put into action for armoury purposes. It was carefully used and well looked after during this period, and when it returned to my direct possession in November, 1944, I decided to bring it right up to scratch and fit it out with as complete a set of equipment as circumstanees would allow.

The Lathe as Manufactured

The first photograph shows the lathe as manufactured and in the condition in which it came into my possession. As can be noted, the saddle is mounted on deep vertical shears on the front of the bed and can be run right by the tailstock which is mounted on the flat upper portion of the bed, being guided in the central slot, which is square-sided, and locked by a clamping-plate and screw. It has the standard form of screw-operated self-ejecting barrel, with a graduated ring on the feed-handle. The lead-screw is housed between the vertical s ears, as is the traverse rack; a geared reduction is provided for the rack-traversing motion. The half-nut for the lead-screw moves in a "vee" slide and is lever-operated.

The bed is of extremely substantial design, the width being some 5 in., whilst the depth over the front shears is $5\frac{1}{4}$ in., and the weight of the bed alone is well over 1 cwt., this for a machine with 4 in. centres and only 12 in. capacity between.

The headstock, too, is of very robust design, the spread of the bearing centres being 8 in. The back-gear is of the normal type mounted on an eccentric back-shaft and all gears are hardened steel.

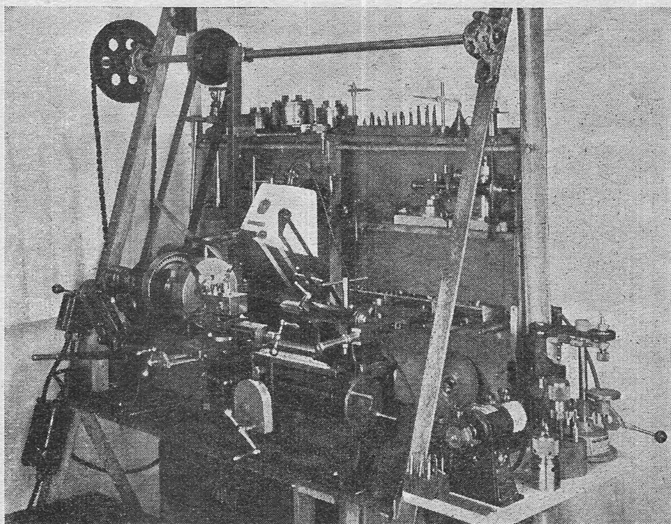
The cone is 3-speed with cones $2\frac{3}{4}$ in. and 4 in. diameter and $5\frac{1}{4}$ in. by $1\frac{1}{16}$ in. face. The large gear-wheel on the mandrel has 120 divisions, and a spring-locking pointer was provided. A sliding lay-shaft below the tail end of the mandrel took the screw-cutting and self-acting drive.

A substantial banjo-plate was provided for the change gears and its studs had floating bushes for the change wheels, with feather keys and screw-on retaining-collars.

The head- and tail-stocks were so designed as to bring the cutting strains of an average sized job more or less directly over the vertical shears; this can be noted in the photograph. Fig. 1 shows the mandrel and its bearings as they were originally. Fig. 2 details the thrust arrangements and an examination of this will show that although the lathe had a hollow mandrel, draw-in collets could not be used, as there was no abutment against which the drawbar could rest. Fig. 3 shows how this was temporarily overcome.

The cross-slide had a square-thread screw and a friction-tight index. It had, however, rather a short cross traverse (this point is referred to later). The top-slide had a long travel, 4 in.,

Photo No. 4. Lathe with 6-in. four-jaw chuck mounted, showing guards, control switches, lever feed to tailstock



and was fastened to the saddle by two bolts working an in "all-round" slot, the bolts being inserted through a special hole from below. The base of the top-slide was graduated in degrees and could be set at any angle through an entire circle.

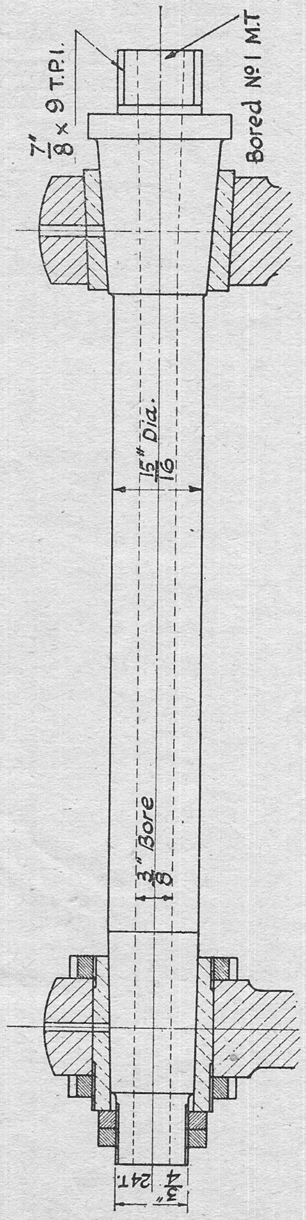


Fig. 1. Detail of original mandrel and bearings

The top-slide was of the form shown in Fig. 4, and it will be seen that the traverse-screw was well protected from dirt and cuttings. Incidentally, this is a vee-thread screw and there was no index. The tool-post was simple but effective, but the traverse of the cross-slide was insufficient to bring the tool-post near enough to the centre-line of the mandrel to bore *small* holes without some overhang of the boring tool or its holder (in a sideways direction, of course).

The lathe was in every way a first-class job; materials were good and workmanship and finish above reproach, and the resulting accuracy of a very high order. In the criticisms that follow, it should be made abundantly clear that there is no suggestion that the lathe was other

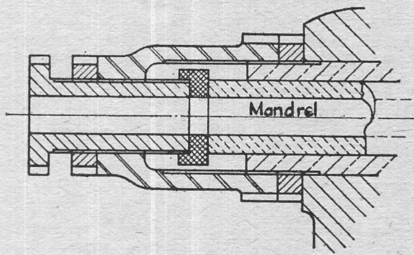


Fig. 2. Original thrust bearing

than a first-class, high-grade job and excellent value for the comparatively high price charged (round about £75); but in the matter of lathes no two people's ideas are identical.

In the first place, the mandrel nose was, to my mind, small—$\frac{7}{8}$ in. × 9 t.p.i., and the hole through it, too, was small—$\frac{3}{8}$ in. and No. 1 M.T. The thrust taken up by fibre washer absorbed quite a lot of power when drilling holes of any size.

The design of the bed, whilst technically excellent, lays itself open to a trouble which is so obvious that it is surprising that no steps were taken to remedy it; the top "vee" forms an ideal natural trap for chips and cuttings, which inevitably lead to undue wear on the slides. The rack being at the bottom is also apt to collect these, ditto the unprotected racking-gear. (Why the rack was not placed in the upper portion of the shears, which would not only have avoided this trouble but would also have resulted in the

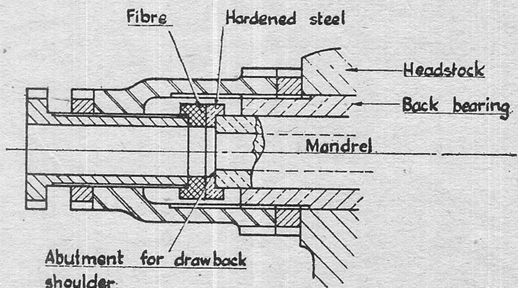


Fig. 3. Temporary modification to original thrust bearing

traversing-handle turning in the direction of traverse, instead of counter to it, I cannot imagine; there are no difficulties in the way of this and I can only assume that the designer had a black-out on this part of a generally first-class job.)

Modifications to the Lathe

As I had three new chucks (a $4\frac{1}{4}$-in. self-centring and $4\frac{1}{2}$-in. and 6-in. independents) to fit to the lathe in addition to the 3-in. genuine " Cushman " which came with it, and incidentally runs practically dead true on both inside and outside jaws, I decided to make up a new mandrel. This was done, and details are shown in Fig. 5. Comparison with Fig. 1 will show that no alterations to gears or cone were involved ; in fact, the old mandrel and its bearings can be re-installed at any time. A double ball-thrust (" Skefko ") was provided and the bearings are now parallel. The front one is substantially larger than the original and is split and adjustable. Both bearings are of chill-cast phosphor-bronze whilst the mandrel itself is of K.E. 805 steel. The type of front bearing used is an excellent one and gives long and trouble-free service ; incidentally, it was used by that master of lathe design, the late Geo. Adams.

A point of great importance with this type of bearing-bush is that the threads on the bush-ends and adjusting nuts should be square. The Vee,

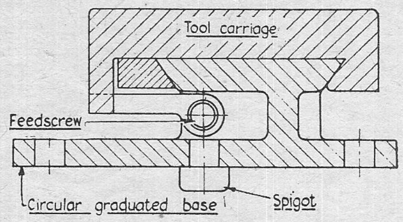


Fig. 4. Cross section of top slide

or Acme form sets up a force component at right-angles to the axis of the bush and tends to close it, especially if the collars are pulled up tight. This, of course, is obvious when one stops to think of it, but might be quite easily overlooked.

The mandrel was bored 17/32 in. and tapered at the nose for No. 2 Morse centres. The nose is $1\frac{1}{8}$ in. × 12 T.P.I. on the screwed portion, and $1\frac{1}{4}$ in. on the plain spigot. Dust-excluding caps are fitted on both sides of the main bearing and wick-feed lubricators to both bearings; these are not detailed in Fig. 5. Incidentally, I always use a very light oil, and the difference this makes to the free running of the mandrel, and to the power absorbed, is surprising.

A brass nose-protecting cap is provided for use when the draw-in collets are mounted. An adaptor and draw-bar for 8-mm. collets are provided and are detailed in Fig. 6 : strictly, they should come under the heading of " accessories," but are so intimately connected with the mandrel that they may, perhaps justifiably, be referred to here.

Cost of Mandrel

In connection with the frequent plea for larger mandrels in lathes built for the amateur, and the statement so often made that such would add little to the cost, it may be of interest to state that the materials alone for this new mandrel, its two bearings and their housings, together with

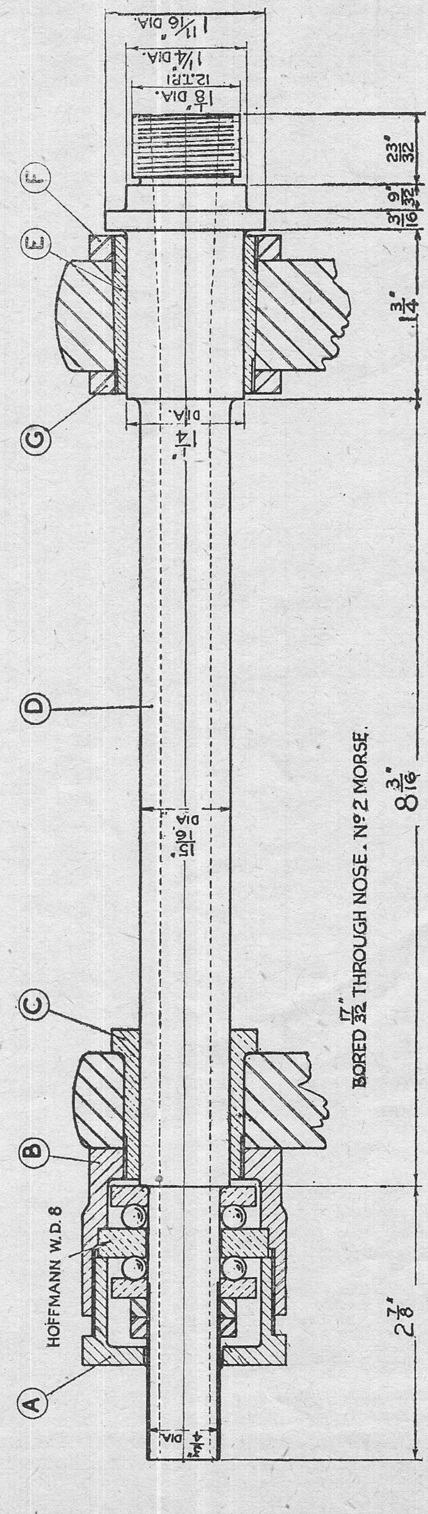


Fig 5. General arrangement of mandrel for 4-in. tool-room lathe

the ball-thrust, cost over £3, whilst the labour involved at normal rates without any overhead or profit (the former at least always a fairly heavy item for the lathe manufacturer), would bring this figure to over £11. I refer here to the bare mandrel, its bearings and their housings,

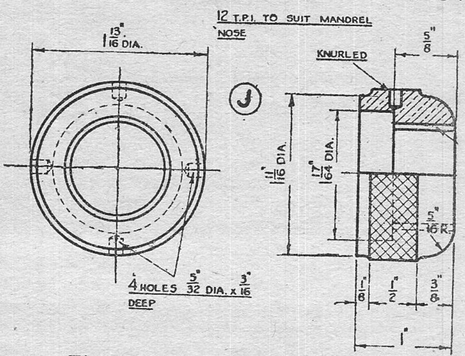


Fig. 5a. Nose protector (brass)

no drawbar, collet adaptors, or chuck backplates being included. In fairness to lathe manufacturers, it must be realised that a substantial mandrel accurately machined, soundly and robustly mounted, and made from first-class material, will always be expensive. I should not hesitate to say that the headstock alone of the machine being described cost, pre-1914 war, considerably more than £15, or round about a figure at which quite a decent complete screw-cutting lathe could be purchased. Further, a larger mandrel, if it is to be of any value, involves larger bearings; these, in turn, require more substantial housings thus increasing the size of the headstock and so it goes on. In effect, an enlargement of the mandrel involves the enlargement of the whole lathe.

Reverting for a moment to 8-mm. collets, it is worth while fitting up any lathe with an adaptor and drawbar to accommodate them. It is quite a simple job, the main points being: (1) to provide a locating peg to ensure the apaptor always going into the mandrel in the same position; (2) to finish bore the adaptor both on the parallel and taper nose portions in position in the mandrel; (3) to see that the bore of the adaptor is a snug fit on the bodies of the collets and that the nose taper is the correct angle, 40 deg. included.

A No. 1 Morse will just take the 8 mm. chuck, but the No. 2 is better, being much more substantial.

Not only are chucks from 4-mm. to 7.2-mm. available by steps of 0.1-mm., but a wide range of centres and other accessories are (in normal times, at any rate) available, many of which are of particular interest to horologists.

The chip trouble was got over by fitting guards seen in photographs 3 and 4. The right-hand one could not be carried right down over the shears as was the left, as it would then have fouled the handwheel at the end of the lead-screw (to be referred to later). The portions of the guards covering the top of the bed are fitted with felt wipers over their whole surface; these are oil-soaked and serve the double purpose of totally excluding swarf and chips and of lubricating the ways. The tailstock has felt wipers held in place by brass plates, both back and front.

Incidentally, the original face-plate, which has been modified to fit the new mandrel, is so

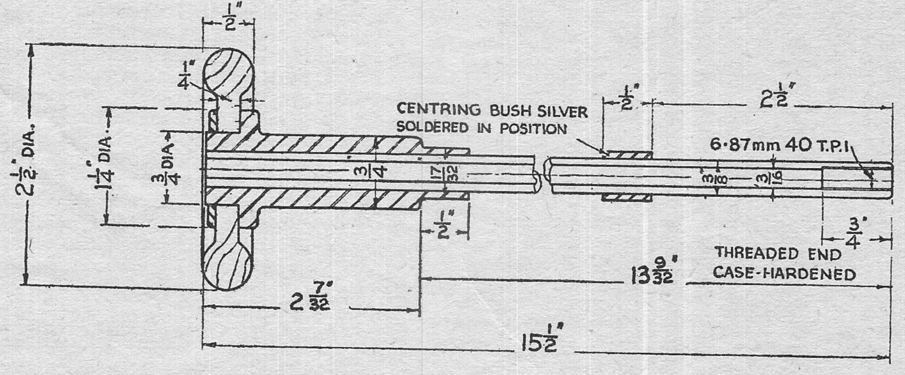
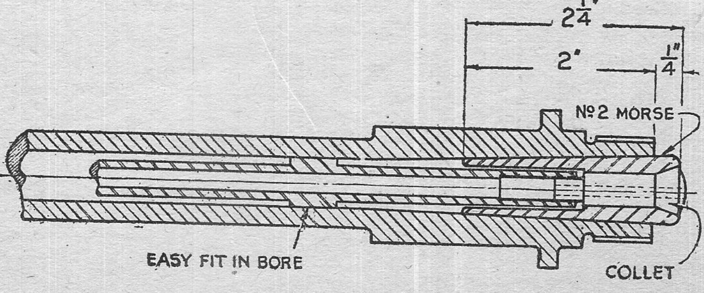


Fig. 6. Above: Detail of drawbar; Right: Adaptor and drawbar-end for 8 mm. collets



large that the left-hand guard has to be removed when it is needed; the rim was too narrow to allow of its being safely reduced in overall diameter, but another face-plate has been constructed, some ½ in. less in diameter, so that the original face-plate will in future be kept for exclusive use with the eccentric turning device to be described subsequently.

A friction-tight index, to read to 1/1,000 in., was made and fitted to the top-slide feed. The simple form of friction device fitted is illustrated in Fig. 7, and is quite effective.

Three additional toolposts were made, a "Willis," a four-way turret and a modified Drummond. The last-named is the one most generally used and its positive height-adjustment feature is very useful. The height-adjusting screw is of brass, in order to avoid risk of damage to slide-top, and has two positions, one for normal turning and one for boring, so arranged that support is given as near the tool as possible,

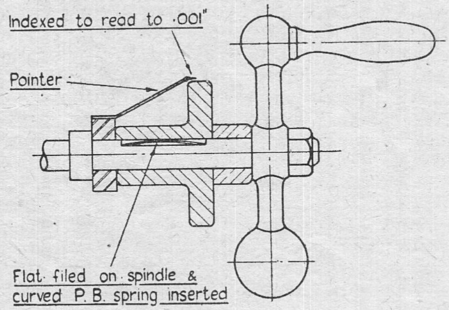


Fig. 7. Detail of friction-tight index to feed handle

which takes quite a lot of stress off the tool-post proper. Socket-headed hardened screws are used for clamping the tools, as detailed in Fig. 8.

A lever feed device was made for the tail-stock, involving the making of a new barrel and tail spindle which had to be bored right through as, naturally, the self-ejecting feature disappeared. The barrel was bored No. 2 M.T., a useful feature when drills over ½ in. diameter are used. This is seen clearly in photographs 3 and 4.

The lever feed can be dismounted and the screw feed reinstated in five minutes; but, except for extra-heavy drilling this is never used. For ordinary drilling, and particularly for screwing and tapping, a lever-feed tailstock is infinitely preferable to a screw-feed, and it is always a matter of surprise to me that it is not more frequently supplied on the lathes intended for the amateur market. The original locking-nut on the tail-stock was substituted by a column nut with a tee-handle coming above the top of the tail-stock. This is plainly visible in the pictures of the lathe in its present condition.

A new feed-screw having a longer extension was made for the cross-slide, and the position of the feed-nut altered with the result of increasing the cross-travel by 1¾ in. At the same time, a more satisfactory index-pointer was made and fitted, and the outer end of the feed-screw was supported by a supplementary bearing close to the handle. The travel now exceeds the centre-height of the lathe.

A brass wheel engraved with 125 *divisions* was mounted on the outer end of the lead-screw and had a pair of handles fixed to it and an index-pointer which acted as a chip-guard in addition to its primary function. As the lead-screw had 8 t.p.i., one division on the wheel = ·1/1,000 in. movement of the saddle. The top-slide base was only graduated 60 deg. on each side of zero; therefore, if it became necessary to swing over to 27½ deg. or 23¾ deg. for cutting Whit. or B.A. threads, the index ran past the zero mark. To remedy this, marks were scribed 2½ deg. and 6¼ deg. beyond the zero, so that when the 60 deg. mark is set to one or other, one gets the desired slide-setting of 27½ deg. or 23¾ deg.

A hand rest with two tees was made up and it often proves of use. *A strip guard* of brass was made to cover the large mandrel gear. A box-guard was also made for the rack-traverse reduction-gear.

Interpolating Dividing Device. As already stated, the large gear was divided with 120 holes and had a spring pointer. I abolished the original pointer and made up a complete new one, to mount on the existing post, having a micrometer adjustment and index. This can be seen fairly clearly in the close-up picture of the head-stock, photograph 5. (Incidentally, the index for this was graduated by means of a 100-tooth wheel mounted on the screw-cutting layshaft and a very crude locking device of brass strip screwed to the lathe bench top, the only necessary precaution being to ensure that backlash was taken up in the same direction all the time.) For the benefit of those who are not familiar with this device, it enables numbers of divisions to be got which are not factors of 120, for instance 25 or 23. A simple calculation has to be made and, in the case of comparatively low numbers, the difference between the chordal and circumferential distances apart of the division holes have to be taken into account. This matter was ably dealt with under "Lessons from the Laboratory," in THE MODEL ENGINEER, April 6th, 1911, I believe by that master craftsman, Geo. Gentry, and, more recently, by the same author in the October 7th, 1937, issue. The 40-thread adjusting screw was screw-cut in the lathe, as accuracy is essential.

That covers all the alterations to the lathe itself, though one or two additions, notably auto cross and rack feeds, are scheduled for attention at the first convenient opportunity.

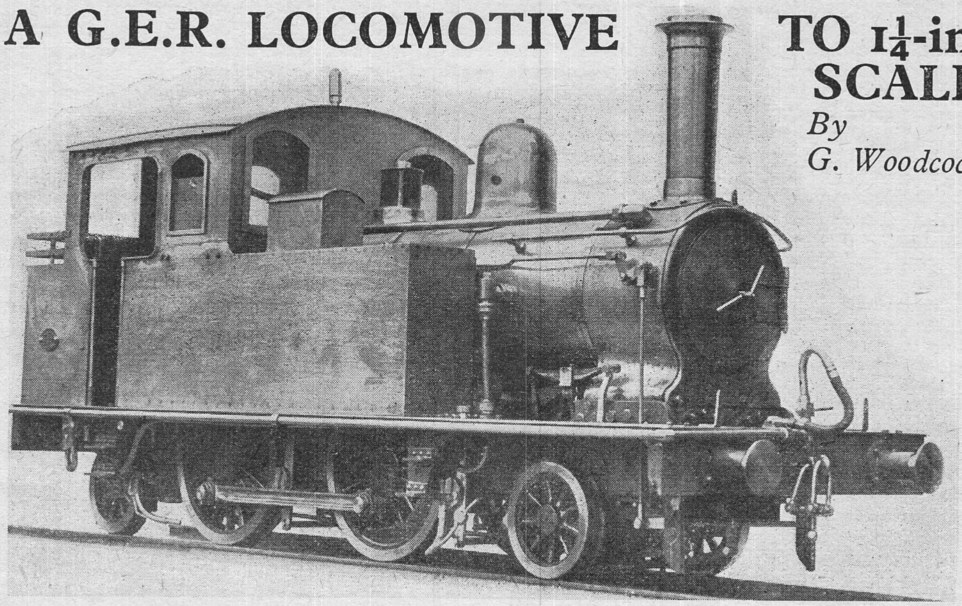
Installation

The lathe was mounted on a self-contained stand made of angle, flat, round and tube steel. This framing is amply gusseted, cross-braced and stayed.

(To be continued)

A G.E.R. LOCOMOTIVE TO 1¼-in. SCALE

By
G. Woodcock



A FEW notes on the prototype of the model about to be described may first be of interest. Twelve of these engines were built by the Great Eastern at Stratford in 1909 to the designs of Mr. Stephen Dewar Holden, the then locomotive superintendent. These twelve were known in G.E.R. times as the "1300" class, being numbered 1300-1311.

When taken over by the L.N.E.R., they became known as "F.7" class. To the drivers, fitters, etc., they were always nicknamed "Crystal Palaces," owing to the large cab windows. They were built for working light "push-and-pull" services such as the Mildenhall branch; also, Bentley-Hadleigh and St. Margaret's-Buntingford services. Later, several were fitted for auto-train working on the Seven Sisters-Palace Gate services and also the short-lived White Hart Lane-Cheshunt service *via* Forty Hill, during the 1914-18 war.

When the Colne Valley and Halstead Railway was taken over by the L.N.E.R., C.V. & H., Nos. 2, 3 and 4, 2-4-2 tanks were withdrawn and "Crystal Palaces" sent to replace them. Later, these were replaced on that service by 0-6-0 tanks of "J.69" and "J.65" classes for passenger service on that line. The leading dimensions were—Cylinders, 15 in. by 22 in.; coupled wheels, 4 ft. 10 in.; wheel base, L.-D., 6 ft. 3 in.; D.-T.C., 7 ft. 0 in.; T.C.-T., 6 ft. 3 in. Total wheel base, 19 ft. 6 in.; radial wheels, 3 ft. 6 in. diameter; boiler, 9 ft. 1 in. by 3 ft. 10⅝ in. O.D.; grate area, 12 sq. ft.; total heating surface, 872.9 sq. ft.; tanks, 1,000 gal. capacity; bunker, 1½ tons; working pressure 160 p.s.i.; weight, empty, 38 tons 3 cwt.; tractive effort, 12,090 lb.

When in their G.E.R. colours with polished brass chimney-caps, cab window frames, etc., they were very pretty little engines. They were somewhat under-boilered and the writer sometimes noted when on the footplate that when an application of the Westinghouse brake was made, a tendency to "pile up" on the trailing springs occurred. At the present time, only about four are still running.

With regard to the model, it was desired to make this as complete as possible with vacuum brake, sanding gear, etc. With regard to the vacuum brake, several of these engines were so fitted by the L.N.E.R.

The writer was for some time employed on engine work at Stratford, and so acquired a good knowledge of the constructional details, which came in very useful.

The frames are from 4-in. × $\frac{3}{16}$-in. mild-steel, 3 ft. long. A good deal of work was involved in cutting out, owing to the rather complex outline. They are braced by the cylinder-block, the leading radial frame, motion-plate, transverse stay at rear of firebox and trailing radial frame, buffer-beams are 1¾ in. × ¼ in. and angled to frames by 1½-in. × 1½-in. × ⅛-in. angles, both sides of frames.

The radial truck guides, or frames, are of box-shape, angled to cheek-plates, which, in turn, bolt to main frames. Hornplates, or horn-cheeks, are riveted into the frame to take the axle-boxes. The driving hornblocks are cast in hard gun-metal, as, at the time this work was in hand, it was impossible to obtain either steel or malleable-iron castings.

The motion-plate was fabricated by facing pieces being brazed on to take slide-bars, which are carried back as in G.E. practice. There is placed below this a plate which carries the valve-spindle guides, as the valves are below the cylinders, and not as in the prototype. It was

considered, however, that the advantages which would accrue from placing them in this position would more than compensate for this departure from scale, as it would permit valves to be set by sight and also render the valve-chest readily accessible for inspection and repair.

The cylinders are in cast-iron, $1\frac{3}{8}$-in. bore by $2\frac{3}{8}$-in. stroke; the port-face is machined at an angle, this being done on the planer after facing and boring of the cylinder barrels. Ports are milled and drilled, being steam $1\frac{1}{8}$ in. × $\frac{1}{8}$ in., exhaust $\frac{1}{4}$ in. × $1\frac{1}{8}$ in. Cylinder covers are attached with correct number of studs, $\frac{1}{8}$-in. Whitworth. Studded glands are fitted to both valve-spindle glands and piston-rod glands. Pistons are bronze on $\frac{5}{16}$-in. rustless-steel rods turned from $\frac{3}{8}$ in. diameter, pistons and rods being turned on centres.

Both piston-heads and crossheads are fitted to rods by correct taper. Crossheads are of the single-bar box-type, first introduced on the G.E.R. by William Adams and used by them to a great extent ever since. The crossheads are steel, planed and turned from solid. They are cottered to rods by $\frac{5}{16}$-in. × 3/32-in. cotters.

Axle-boxes are bronze with cast-iron keeps. Axle journals are $\frac{7}{8}$ in. diameter by $1\frac{1}{8}$ in. long. The crank-axle is turned from solid, a piece of flat 3-in. × $1\frac{1}{4}$-in. × $8\frac{1}{2}$-in. mild-steel being used. The crank shape was hacked out with a coarse-tooth hand hacksaw, the ends being centred; the portion between the two crank-throws was then turned to $\frac{15}{16}$ in. roughly. The turned portion was then heated to bright red with the gas blowpipe. One web was gripped and the other twisted to 90 deg. with a pair of Stillsons. The crank was then finished as an ordinary forging. Nothing very difficult, and I fail to see why any fuss is made of turning shafts from solid. In any case, there is no need to turn a shaft from round-section material—it is only a waste of time. Total time for the crank under consideration was 15 hours, including hacksawing and turning on a treadle lathe.

The wheels are of cast-iron $6\frac{1}{8}$ in. diameter on tread. The wheel centres are cast-iron, and steel tyres are fitted to both coupled and radial truck wheels. These I cut from $\frac{7}{8}$-in. plate with oxy-acetelyne cutter. These rings so formed were then machined in the usual way. Each tyre has correct lip to take side thrust.

The wheel centres were forced on the axles and then turned to calipers as accurately as possible. The size was taken from the calipers with an inside micrometer. A shrinkage allowance of 0.006 in. was allowed. Incidentally, this is the same allowance as is used on the full-size job, where it is customary to allow 0.010 in. per foot of wheel diameter.

When the tyres were shrunk on they were finish-turned on the wheel centres. The crank-pin holes were bored prior to forcing the axles into the wheels, one wheel having been left loose for quartering. The side rods were made from $1\frac{1}{4}$-in. × $\frac{1}{2}$-in. steel—they are fluted; this was done on the planer, the ends being rounded out afterwards with a milling cutter in the lathe. Connecting-rods have correct strap big-ends with bolts and cotters. The rods are small forgings

The valve-gear was a rather tight job, owing to the fact that I had only $1\frac{1}{8}$ in. to get four eccentrics in between the two crank-throws. As each eccentric-strap could be only 9/32 in. wide at the most, cast-iron or gunmetal eccentric-straps were out of the question, owing to the possibility of fracture through the bolt-holes. Therefore, I decided to make them out of steel and harden them deeply. This also involved hardening the eccentric-sheaves. These were made in two halves in order to get them on the axle. They are held together by 3-B.A. Allen cap-screws. While hardening, the sheaves were held together with temporary screws to avoid distortion; the same applied also to the straps. The straps and sheaves were then lapped to each other with "Bluebell" metal-polish mud. The rest of the motion, expansion links, suspension-links, etc., is in steel, pack-hardened. It is all rather on the slender side in order to arrange it in the space of $1\frac{3}{8}$ in., limited by the crossheads.

Weight-shaft turns in two split plummer-blocks with gunmetal liners. It is operated by the correct G.E.R. 3-start screw, 6 lead, 18-t.p.i. square-thread, cut with a tool 1/36 in. wide. At the time the screw was cut, a tap was made, also cut with a tool 0.002 in. wider.

The spring gear for all wheels consists of laminated springs. These for the coupled wheels were under-hung.

Cylinder-cocks are operated from the cab through a small bell-crank to a shaft turning between the leading guard-irons. Screw-couplings are fitted. Buffers are of steel.

The chassis being complete, the boiler was put in hand. This is in copper, close-riveted with $\frac{1}{8}$-in. rivets pitched three diameters. Barrel is 5 in. O.D. × $10\frac{1}{2}$ in. long, 16 s.w.g. Firebox outer wrapper sheet 3/32 in. thick, $6\frac{1}{2}$ in long; inner plate 3/32 in. thick; all others are $\frac{1}{8}$-in. plate.

The boiler was silver-soldered all over, though this size boiler is about the limit for which I should use this method of construction. There are twelve $\frac{1}{2}$-in. tubes. One hollow longitudinal stay is fitted for blower.

Firebox is stayed with twenty-four 5/32-in. stays. Roof stays are $\frac{3}{16}$ in., and there is one girder stay from outer to inner wrappers.

The boiler was tested to 175 p.s.i. hydraulic and 120 p.s.i. steam for a working pressure of 70 lb.

The smokebox is of steel with flanges and end-plates; the chimney is turned from $1\frac{3}{4}$-in. O.D. hydraulic barrel, which is surmounted by the standard S.D. Holden brass cap. The smokebox, chimney, etc., are polished bright.

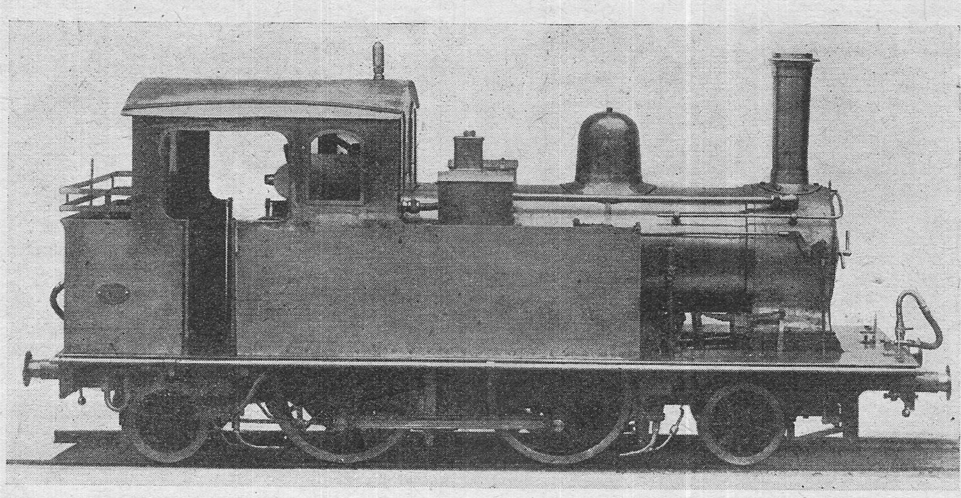
The boiler fittings include regulator, blower, injector stop-valve, whistle-valve, sanding-gear, application valve, vacuum brake, ejector stop-valve, connection for displacement lubricator and pressure-gauge connection.

Boiler is lagged by 24-s.w.g. nickel-bronze. Dome cover is made from brass sheet in three pieces, as is also the safety-valve casing. These last two items are also polished.

The side tanks, cab, tool boxes and bunker are also in nickel-bronze. Tanks and cab are built up with angle and riveted.

A hand-pump is located in the left-hand tank, the handle projecting into the tool box.

The cab has six windows as in the prototype,



the two side windows being of the drop-type, dropping into recesses in the tanks. The back weather sheet of the cab is removable for driving.

The bunker has a false bottom. It is not arranged to carry water, because the fitting up of the brake cylinder was very tight owing to the close proximity of the trailing radial. Therefore, the flexible connection, a coiled pipe to allow for the movement of the brake cylinder on the trunnions, required a fair amount of space. As the brake-shaft passes below, the bunker arms are fitted to take both vacuum-brake cylinder and hand-brake. Brake cylinder is 2 in. bore, and is fabricated from brass tube, the trunnions brazed on, also flanges to take top cover. The plunger is turned a tight fit without packing. A small hole is drilled on the underside of the cylinder for the purpose of equalising. The brake ejector is also fabricated ; the cones are made adjustable.

Attached to the application disc is the steam-valve. Thus, when the disc is moved to brake off, the leakage holes to the train pipe are opened ; thus the train pipe is at atmospheric pressure. When the brake is in the " on " position the train pipe is closed by the moving of the application disc and opening the steam valve ; the vacuum is created in the train pipe and the brake applied.

The use of cocks on the engine connections, as can be seen in the photograph, while not correct practice, is to prevent leakage as would probably occur were the conventional " dollys " used.

With regard to the steam sanding-gear, this is quite a straightforward job. The sand application valve is placed on the left-hand tank. There are three positions, *viz.*, off, leading sands and trailing sands. Sand-boxes, as can be seen, are placed behind the footsteps. A sand-trap is placed below each box.

This, I think, covers the more interesting points of the engine. There is no paint above footplate level, everything being finished bright, as this is easier to clean. The only items purchased were—5- and 6-B.A. screws and nuts ; 3/32-in. and 1/16-in. right-hand screws and nuts ; 1/8-in. × 3/32-in. copper and brass rivets, and one pressure gauge. All other fittings, etc., were home-made.

Stephenson Locomotive Society

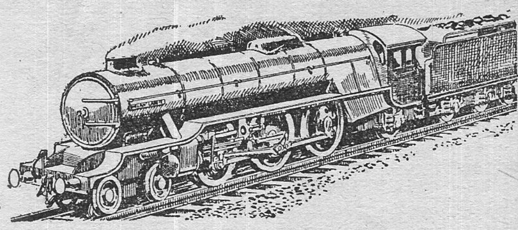
On April 28 a large party of members and friends travelled by special train from Hythe to Littlestone and back on the Romney, Hythe and Dymchurch miniature public railway in Kent. The locomotive hauling 12 bogie cars in each direction for a non-stop run was 4-6-2 *Doctor Syn* of the Canadian Pacific type. The sister engine, *Black Prince* was undergoing repair in the well-equipped shops at the time and No. 5 *Hercules*, the one remaining 4-8-2, was away for general repair at the Ashford Works S.R., but all the other locos (modelled on the first Gresley 4-6-2 type) were running as of old, since passenger and shingle, etc., traffic is heavy and a particularly busy summer season was anticipated. The owners, and also the manager, of the line most kindly granted every facility, arranging excellent meals as well as the special train travel at moderate rates.

The April issue of the Society's monthly illustrated *Journal* was a special Irish number, containing many rare illustrations ; it was quickly out of print.

General Secretary, H. C. CASSERLEY, Ravensbourne, Berkhamsted, Herts.

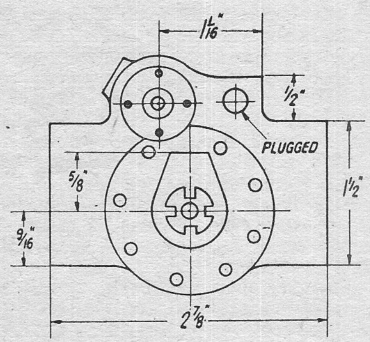
"HIELAN' LASSIE"

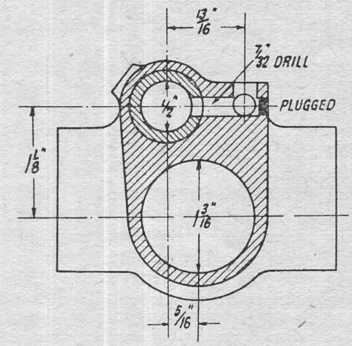
By "L.B.S.C."

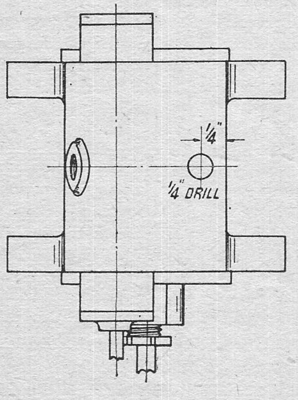


IN fulfilment of promise, here are the details of a set of proper piston-valve cylinders suitable for the "Lassie." Second thoughts are best, says the old saw; at first, I just merely intended to explain briefly how the L.M.S. type piston-valve cylinders described about a year ago could be adapted to the "Lassie," but L.N.E. and L.M.S. do not mix very well, and I would have had to do something about the middle cylinder, anyway. Therefore, your humble servant decided to "go the whole hog" and get out the drawings, as originally intended, for the proper piston-valve cylinders which I intended specifying before I received the numerous requests to substitute slide-valves. Talking about second thoughts being best, they certainly were best for the good folk who obtain amusement and recreation from these notes. I was recently offered the job of trying to emulate Billy Stroudley, on the Romney, Hythe and Dymchurch Railway, with a house at Littlestone, enough ground to put up a long non-stop multiple-gauge road for my own fleet of locomotives, and a private 15-in. gauge locomotive for my own use over the "main line." Curly was sorely tempted; but I finally decided that the upheaval was too great at my time of life, when I should, by the good rights, be retiring instead of making a complete new start, so, with much regret, I let the chance go by. Incidentally, it would have meant the sudden finish of these notes, and somebody else would have had to have given instructions for finishing the "Lassie."

As a matter of fact, the piston-valve cylinders shown in the accompanying illustrations are easier to make than the slide-valve type, provided that you have a decent lathe that will turn reasonably true, and that you have the average amount of skill in the use of it. The flat joints between cylinder-block, steam-chest, and cover are wiped off the slate at one fell swoop; no slide-valves to mill out, no slotted ports to cut, no valve-spindle gland to bother about; the only "extras" are a couple of drain cocks or relief valves to each cylinder, to let out the water when starting up from all cold. All the existing holes in the frame will be O.K. (they would have needed alteration for the L.M.S. type of cylinders) and no alteration will be needed to the valve-gear, except that the return cranks and middle eccentric follow the main cranks instead of leading them, and the connections at the top of the combination lever are reversed, doing away with the knee-jointed valve crosshead. Below you will find a few "'ints and tipses" on the machining and fitting.





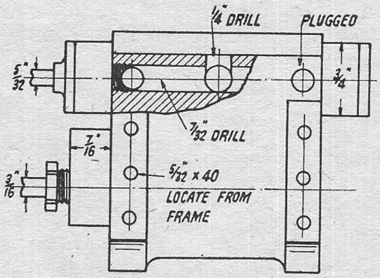


End view, section and plan of inside cylinder

How to Bore the Castings

First check the core-holes in both inside and outside cylinders; if they don't tally with the centre measurements given on the drawings, clean one end of each, plug the hole and mark out as described for the castings of the slide-

valve cylinders. Then clean up the bolting-face on each casting, mount on angle-plate as for slide-valve cylinders, and set the main bore to run truly. Face off the end of the casting, then bore and ream as described for the slide-valve cylinders. When this is done, slack the angle-plate on the faceplate—*don't loosen the cylinder*; very important that!—and shift the angle-plate about until the core-hole, or marked circle, as the case may be, for the steam-chest or valve-chamber, runs truly. Tighten the angle-plate again, then proceed to bore out the valve-chamber exactly as you did the main bore, finishing off with a $\frac{3}{4}$-in. parallel reamer if you have one. If you haven't, use a bit of $\frac{3}{4}$-in. round rod for a gauge, and bore to exact fit. The exact *size* doesn't matter, as the liners are turned to fit; and that reminds me of a funny incident concerning a relation of Inspector Meticulous, and a strict follower of text-book lore. He was making a pair of piston-valve cylinders, and carefully bored and reamed the valve-chambers; after which he proceeded to turn the liners, measuring same with a "mike." When completely finished, ports cut and all, he found to his dismay



Part-section, showing exhaust passage

that the liners were a nice sliding fit instead of a press fit, and wrote and asked me what was the matter with the text-book, as a $\frac{3}{4}$-in. liner should be a press fit in a $\frac{3}{4}$-in. hole. So it should—in theory; and that's the rub! The reamer cut a bit large, as reamers frequently will; and he could have saved himself all the trouble and disappointment if he had applied a little "common savvy" to the job, by turning his liners to a "mike measurement" a shade larger than the "theoretical" fit, and then finishing the job by trial and error. All Curly does is to turn the projecting bit of the liner to a tight push fit in the casting, then turn the cross-slide handle back half-a-turn, bringing it back again to within half-a-division of its original position. The rest of the liner is turned to that setting, and it takes plenty of "Sunny Jim" under the spindle of my bush press to get the liner well and truly home. It never shifts any more!

Whilst you have the angle-plate and faceplate all rigged up, bore all three castings, both main and valve-chamber bores; after which you can put on the three-jaw, turn up a stub-mandrel to fit the main bore, and face off the other ends of the castings, taking the facing cut clean over the full surface of the end, valve-chamber and all. The angle-plate is then replaced, and the castings up-ended on it, in turn, for facing off the side flanges of the inside cylinder, and the bolting-face of the outside cylinders, exactly as described for the slide-valve cylinder castings; only this time you have no port faces to bother about, and no ports to cut. The distances from edge of main bore to inside cylinder flanges and outside-cylinder bolting-faces is the same as for the slide-valve cylinders already given.

Steam and Exhaust Passages

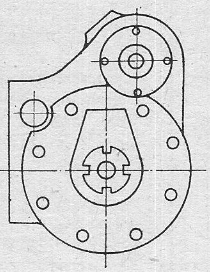
A boss will be found on the casting, on the outside of the valve-chamber, and this is drilled 7/32 in. and tapped $\frac{1}{4}$ in. by 40 for the steam pipe. Both inside and outside cylinders have the connection between valve-chamber and bore made with three No. 30 drill holes. These start from the lip of the bore, exactly the same as on the slide-valve cylinders, but they break through into the valve-chamber $\frac{1}{4}$ in. from the end, as shown in the longitudinal section of the complete cylinder.

The exhaust-ways are very simple. On the inside cylinder casting, there is a sort of "step" extending full length, alongside the valve-chamber. At $\frac{3}{16}$ in. from each end of the casting, and level with the centre-line of the valve-chamber, make a centre-pop on the side of the step, and drill a hole horizontally, with a 7/32-in. drill, right into the valve-chamber. The edges of these holes will be a full $\frac{1}{16}$ in. from the ends of the casting. Next, on the end of the cylinder, level with centre of valve-chamber, and about $\frac{1}{4}$ in. from the edge of the step, make another centre-pop; then, using drilling-machine or lathe, drill down the length of the cylinder until the drill, cutting across the first cross-hole, breaks into the second. See side view of inside cylinder, which is shown partly broken away to expose this hole. Finally, on top of the step, $\frac{1}{4}$ in. from the edge, and midway between the two ends of the casting, drill a $\frac{1}{4}$-in. hole to break into the longitudinal hole. Put the 7/32-in. drill into the long hole again, to clear off any burrs, shake out the chippings, tap the open end of the longitudinal hole $\frac{1}{4}$ in. by 40, and screw in a very shallow brass plug. The top of the step should be faced off with a file, as the exhaust connection will be made with an oval flange attached by two screws, the flange covering the $\frac{1}{4}$-in. hole.

The exhaust-way of the outside cylinders is even simpler. On the bolting-face, $\frac{1}{2}$ in. from the top and $\frac{3}{16}$ in. from each end, make a couple of centre-pops, and drill them diagonally with a 7/32-in. drill, right to the valve-chamber, aiming the drill at the centre-line of same. Next, on one end of each cylinder, make a centre-pop $\frac{1}{4}$ in. from the bolting-face and $\frac{5}{16}$ in. from the top. Note, these have to be made on the rear end of each cylinder, as one is right-hand and one left. Using drilling-machine or lathe to ensure truth, drill a $\frac{1}{4}$-in. hole, right down the cylinder as before, until the drill breaks into the diagonal hole at the other end. Put the 7/32-in. drill in the diagonal holes again, to shift the burrs, then open the end of the long hole with 9/32-in. drill for about $\frac{3}{16}$ in. depth, and tap it $\frac{5}{16}$ in. by 40. Tap the ends of the diagonal holes $\frac{1}{4}$ in. by 40, and when the liners have been fitted, screw in little brass plugs,

filing same off level with the bolting-face. Be careful, when doing the plugging, that the drilled holes are not obstructed in any way whatever.

Before fitting the liners to the valve-chambers, fit the front and back covers to the main bores; this can be done much easier when both ends of the cylinder castings are perfectly clear and

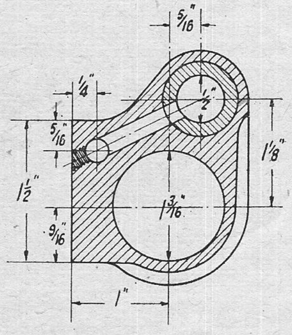


End view of outside cylinder

unobstructed. The bits which have to be nibbled out, to clear the ends of the valve-liners and the exhaust way of the outside cylinders, can be attended to after the covers have been fitted. No further instructions are needed on the covers and piston glands, as they are exactly the same as described previously for the slide-valve cylinders; as are the pistons and rods, so you can go right ahead and fit them as well.

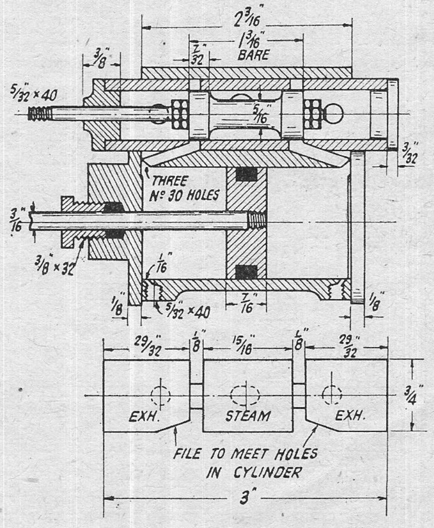
Valve-Liners

About the best material from which to machine the valve-chamber liners, is close-grained hard cast phosphor-bronze, either cored or solid. If that isn't obtainable (our casting suppliers may oblige) good-quality drawn bronze or gun-metal would do. If you have a good stiff lathe that will turn work projecting over 3 in. from a chuck without chatter, the liners can be turned at one single setting. Chuck a piece of metal the nearest size larger than $\frac{3}{4}$ in., with just over



Cross-section through exhaust-way

3 in. projecting; face the end, centre, and bring up the tailstock to help support the metal. Turn down the outside to about 1/64 in. over $\frac{3}{4}$ in. diameter, then finish the job to press-fit size by the method mentioned earlier in this note. Drill down a little over 3 in. depth, first with $\frac{3}{16}$-in. drill, then with a 15/32-in., finally opening out and, at the same time, truing up the hole with a boring tool, until the "lead" of a $\frac{1}{2}$-in. parallel reamer will just enter. At 29/32 in. from the end, cut a groove $\frac{1}{16}$ in. deep with a parting-tool $\frac{1}{8}$ in. wide, and $\frac{15}{16}$ in. farther along, repeat the process; then part off at 3 in. from the end. With a thin flat file, file across the bottom of the groove on opposite sides, so as to cut into the bore of the liner, leaving two connecting-pieces about $\frac{1}{4}$ in. wide, to hold the liner together; also bevel-off the bottom of the liner on the outer side of each groove, as shown in the detail illustration, to make communication between the passage-ways drilled in the cylinder, and the ports in the liner. The liners can then be squeezed home, using the vice as a press; allow an equal amount to project from each end of the cylinder. Now put a $\frac{1}{2}$-in. parallel reamer carefully through the liner, as described when hand-reaming the slide-valve cylinder bores. If you like, before squeezing the liners into the cylinders, they can be chucked in the three-jaw, and the reamer given a "preliminary canter" so to speak, through each liner; but



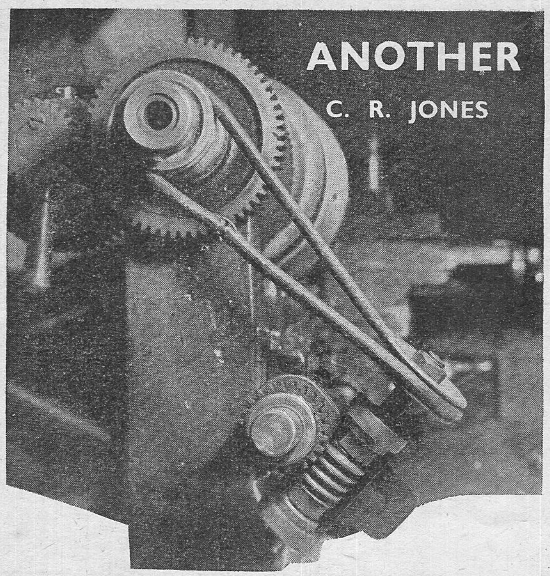
Section of cylinder

this won't do for a finish cut, as the liners will be distorted a little when squeezing in, and the reamer will have to be put through again in any case, to give them a final true-up. That reminds me of some instructions I once read, wherein the writer told his readers to ream the liner, and then fit the piston-valve to it, as this could be done much easier with the liner out of the valve-chamber than in it. Very nice, too; the only trouble was that cylinders in metal behave rather differently to cylinders on paper! Nobody need have the slightest difficulty in getting the valves the correct length; before squeezing the liners into the valve-chambers, wrap a piece of white paper around each, and rub your fingers up and down it a few times. The exact location of the ports will be clearly shown on the paper, and will serve as a guide to get the exact length of the valves. Simple, but effective!

(Continued on page 512)

ANOTHER LATHE SLOW-FEED

C. R. JONES



I WAS very interested in the ingenious slow-feed arrangement for a 3-in. lathe, in the March 14th issue of THE MODEL ENGINEER, by Mr. W. T. L. Sloan. I have used a slow-feed arrangement for my 3-in. "Winfield" lathe for some years now, which has given every satisfaction and of which, perhaps, some readers might like to have the details.

It mainly consists of a worm (cut to mesh with the change-wheels supplied with the lathe) mounted on a spindle with a pulley at one end, which spindle is housed in a bracket provided with suitable bearings. This is mounted on a quadrant which fits on in place of the one supplied with the lathe, and the pulley is connected by means of a round leather belt to another pulley suitably mounted on the tail-end of the lathe mandrel.

Taking the parts in the order made, the bracket *A* was made from a piece of 1-in. × $\frac{1}{4}$-in. B.M.S. bent to the shape and size shown, the holes for the bearings being marked off from the base, $\frac{11}{16}$ in. at the shorter end, and $\frac{15}{16}$ in. at the longer end.

These marks were centre-popped and centre-drilled, and then drilled through by means of a drill held in the lathe chuck, the bracket being fed up by means of the back centre.

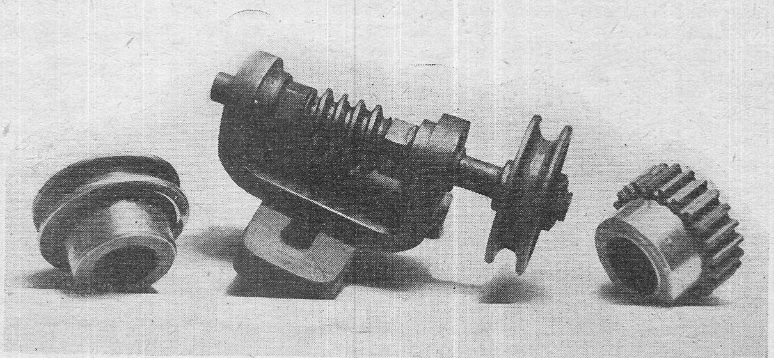
The finishing drill size was $\frac{1}{2}$ in. diameter.

Two bushes *B* were then turned up from $\frac{3}{4}$-in. diameter bronze, the flanges being finished $\frac{1}{8}$ in. thick and the rest turned down to a press-fit in the holes in the bracket *A*. The holes in bushes were $\frac{5}{16}$ in. diameter, and, after pressing in, were finished with a parallel reamer.

The worm *C* was next tackled, and it was found that six threads per in. seemed to mesh well with the change-wheel teeth. This is a fairly coarse thread to cut on a small lathe, so the worm was made from bronze, as it was thought that this would be much easier to cut than steel, the tool used being ground up similar to one for cutting an Acme thread.

As only a short length of bronze was available at the time, it will be noticed that the worm shown in the photographs is shorter than that shown in the drawings, and was simply pinned to the shaft, two bored-out nuts being used for distance-pieces. A superior arrangement would be to make the worm as shown in Fig. 1, and secure by means of a grub-screw biting on a flat filed on the spindle. The spindle *D* was a $3\frac{5}{8}$-in. length of $\frac{5}{16}$-in. silver-steel, threaded $\frac{5}{16}$ in. B.S.F. for a distance of $\frac{3}{4}$ in. at one end for securing the pulley *E*, which was a brass sash-pulley $1\frac{1}{2}$ in. diameter; this was bored out to $\frac{5}{16}$ in. and secured to shaft by means of two nuts.

The driving-pulley, Fig. 3, was exactly similar to pulley *E*, and a steel bush *G* was made provided with a grub-screw for attaching to lathe mandrel, the pulley being bored out to suit the bush and was simply sweated to it.



Components of feed arrangement

The quadrant *H*, Fig. 2, was made from a bracket found in the scrap-box; it was bored out to fit on the extension on lead-screw bearing-bracket, and was provided with a $\frac{1}{4}$-in. B.S.F. set-screw for fixing. A slot, $\frac{1}{4}$ in. wide by $1\frac{1}{4}$ in. long, was cut and filed where shown to give adjustment for meshing worm with change-wheels.

A hole was drilled in the centre of the base of *A* and tapped $\frac{1}{4}$ in. B.S.F. for securing it to the quadrant.

The toothed wheel shown in the photographs

is a 23-tooth fibre wheel which I picked up somewhere or other, and fitted with a suitable bushing; I use it for quite a lot of general traversing. This gives a feed of about 184 to the in.

Using a 65-tooth wheel on lead screw a feed of 520 per in. is obtainable. These feeds are with pulleys of equal diameter.

The main advantages of this system are the ease with which it can be fitted up and dismantled, the quiet operation, the saddle can be driven in either direction by just changing twist of belt; also, if changing over to screw-cutting, the train of wheels can be left set up on lathe quadrant and put on quickly.

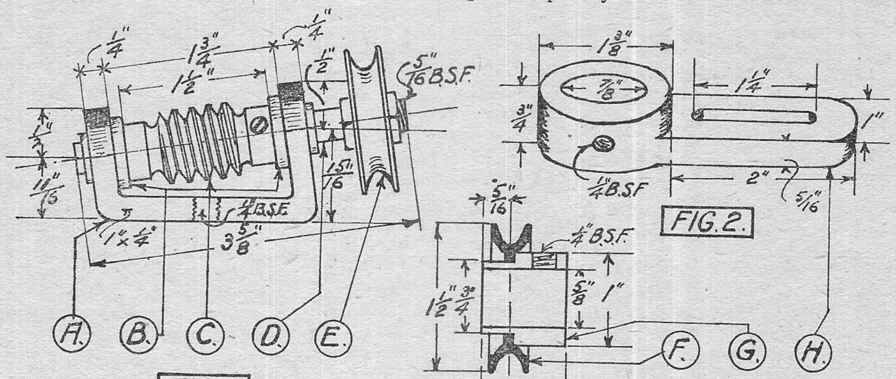


FIG 1. FIG. 2. FIG 3.

It should be pointed out that different lengths of belts will have to be made up (from sewing-machine belting) to suit different sizes of change-wheels.

Hielan' Lassie

(*Continued from page* 510)

After pressing-in the liners, run the 7/32-in. drill into the diagonal holes in the outside cylinders, and the horizontal cross-holes in the "step" of the inside cylinder, piercing the liners; also drill down the steam inlet, right into the liner. Put the reamer through the liner bores again, to remove any burrs, and then the covers can be fitted. These are turned up from $\frac{3}{4}$-in. round bronze or gunmetal rod—brass will do at a pinch—and being just another kiddy's practice job, need no description. When doing the back one, turn the $\frac{3}{16}$-in. spigot to a tight fit in the bore of the liner, then centre, and drill No. 23 for about $\frac{1}{2}$ in. depth. Part-off a full $\frac{3}{8}$ in. from the end, reverse in chuck, turn the other end, and poke a 5/32-in. reamer through the centre hole, so that it will be a nice fit for the valve-spindle. The covers can be attached by four $\frac{1}{16}$-in. or 10-B.A. screws tapped into the thickness of the liner, as shown, or a couple of countersunk screws can be put through the liner into the spigot of the cover, as described for the L.M.S. cylinders a year ago. As these liners are not counterbored like the L.M.S. type, the edge screws can be used with safety, as there is only the exhaust pressure to withstand, and that isn't much on your humble servant's locomotives!

Piston-Valves

Last, but not least, we come to the actual valves, which can be machined at one setting from a bit of rod held in the three-jaw. Either rustless steel or bronze will do. Face the end, centre, and drill down about $1\frac{3}{8}$ in. depth with No. 20 drill (the spindles have to be a "floating" fit); then rough out the bobbins to 1/64 in. over size, turning the space between them to a diameter of $\frac{5}{16}$ in. Run a parting-tool in $\frac{1}{16}$ in. or so, at the proper distance from the end, which should be $1\frac{3}{16}$ in.; then carefully turn the bobbins, same as previously given for turning the slide-valve cylinder pistons, to an exact sliding fit in the liners. Part off, and re-chuck, taking a very fine skim off each end, to give the necessary exhaust-clearance. Beginners, note that the steam laps are *inside*, with an internal admission piston-valve.

The valve-spindles are $3\frac{1}{8}$-in. lengths of 5/32-in. ground rustless steel; one end is screwed 5/32 in. by 40 for about $\frac{3}{16}$ in. length, and the other end either 5/32 in. by 40, or 60 if the fine thread dies are available, for $1\frac{5}{8}$ in. length. Make four locknuts to suit, for each spindle. The valve is mounted on the spindle so that it is quite free to turn between the lock-nuts, but it must have no appreciable end-play. The whole lot is then assembled as shown in the illustrations, the pistons being packed with square braided graphited yarn, and the glands with the ordinary loose yarn. No paper or composition joints are needed between the covers and ends of the liners, though they are used between cylinder covers and flanges. The cylinders are erected in the frames, exactly as given for the slide-valve cylinders, as the bolting-faces, length and overall heights are exactly the same.

*A CONGREVE CLOCK

By Dr. J. BRADBURY WINTER

IT only remains to connect the governor with the clutch in the "movement." A pair of sheet steel plates $\frac{3}{16}$ in. thick are bolted to the front part of the "fore and aft" angle-irons in such a position that the $\frac{1}{4}$-in. bearing holes at their tops are $3\frac{5}{8}$ in. from the centre of the vertical clutch shaft. (See Fig. 42.)

A shaft, $\frac{9}{16}$ in. diameter, is pivoted between these plates, carrying two arms at right-angles to each other. It may be thought that the shaft is needlessly thick. The reason for this is that the arms are only fixed with tapered pins. The othodox method would be to cut key-ways, the pins merely preventing longitudinal movement; but if the shaft is made stout enough to give the pins a big bearing surface, there is no need for keys. We have the necessary space for a big shaft, so we can save ourselves that labour. Incidentally, the appearance is quite pleasing, not at all clumsy.

The two levers are identical. Dimensions are given in Fig. 43. This is a similar job to the forked ball-rod, almost entirely made in the lathe. Chuck a piece of 1-in. mild-steel rod in the four-jaw, $5\frac{1}{4}$ in. long, pushed right in against the nose of the mandrel. If the lathe is fairly robust, there will be no difficulty in turning the ball at this instance out from the chuck; but if that should be asking too much, support it with the back centre.

Face off the end, and mark a line $\frac{1}{2}$ in. from it, as before. Turn the ball to fit a template of $\frac{1}{2}$-in. radius without effacing the line or the centre of the face. Turn the shaft, tapering from $\frac{3}{8}$ in. diameter near the ball down to $\frac{5}{16}$ in. at a point $2\frac{9}{16}$ in. from the line on the centre of the ball. The same template "B" can be used to make the radius, the line on the template being held at $2\frac{9}{16}$ in. from the line on the ball; or a new template may be made with the complete reverse curve cut out.

To complete this end, the metal must be withdrawn from the chuck far enough to allow for eventual parting-off. Turn down to $\frac{13}{16}$ in. diameter, or perhaps better if left at 27/32 in. Part off at $3\frac{3}{4}$ in. from the centre of the ball.

We now have to put a $\frac{9}{16}$ in. hole through the ball to fit tight on the shaft. Even if you have a drill of that size, it will be no good for the job, first because the hole would certainly not be a tight fit on the shaft, and second because it would not be possible without special holding equipment and jig to drill the hole anything approaching centrally.

The rod must be set up on the faceplate, lying with its axis parallel with the plate, and the ball running true at the centre. Make a brass washer with about $\frac{5}{8}$-in. bore, $\frac{3}{16}$ in. thick, and large enough to bridge across the central hole in the faceplate. Lay it on the plate to act as a pillow for the ball; pack up the other end of the lever to bring its axis parallel with the plate; clamp it down lightly. File a small flat on the ball, holding the file parallel with the plate, and put a centre-pop in the centre of the flat circle so formed. Set it up true with my pointed wire tool. Clamp tightly. Drill and bore the hole just too small to take the $\frac{9}{16}$ in. shaft. This can be reduced with a fine file and emery cloth till the lever slips on it to come tight on reaching its appointed place, one lever from each end.

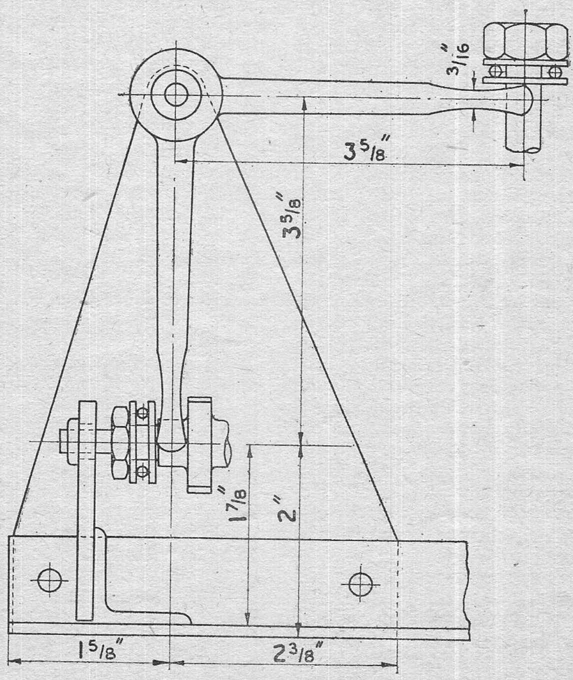


Fig. 42. Clutch levers and bearing plates

Now pass the shaft through the hole, and saw two cuts parallel with it to leave the forked end a good $\frac{5}{16}$ in. thick, and file to a finish; be careful that the surfaces are exactly parallel with the shaft, so that the lever will bear evenly on the ball-race. Cut out the fork, $\frac{9}{16}$ in. gap.

The prongs must be scooped out as shown, probably by filing to a template of 2-in. radius. Mr. Stephens set his levers up on the faceplate and formed these contours with a boring tool. He spent a couple of hours making a jig, after which, the actual shaping of the four curves was quickly done and made a pretty finish.

* *Concluded from page 470, "M.E.," May 9, 1946.*

Now make the two tall bearing-plates (Fig. 42) from $\frac{3}{16}$ in. sheet steel; no need for brass bushes. Fix them to the "fore and aft" angle-irons (one of them is indicated in Fig. 37). The bearing hole should come about vertically above the appropriate part of the governor when located at $3\frac{5}{8}$ in. from the centre of the vertical shaft, as shown in Fig. 42.

Now turn a $\frac{1}{4}$-in. pivot at each end of the shaft. Assemble the whole unit, with the vertical lever on the shaft approximately in its proper place to let its fork embrace the governor sliding-piece.

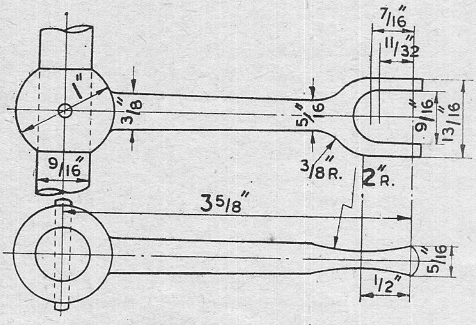


Fig. 43. Two views and dimensions of clutch plates

Adjust it accurately; remove one bearing-plate and shaft and lever. Drill, broach, and fit a tapered pin.

When making the clutch cones, I said the solid cone might be bored 17/32 in. A piece of stout-gauge brass tube, say 9 in. long, $\frac{9}{16}$ in. external diameter, and with a large enough bore to slip loosely over the $\frac{3}{8}$-in. vertical shaft, is now to have a thread cut on it at its lower end for about $\frac{7}{8}$ in., 32 threads per inch; and two brass nuts about $\frac{3}{8}$ in. thick are to be made to screw on it, one locking the other, and thus providing adjustment for the length of the tube.

The lower nut should come about $\frac{1}{8}$ in. below the end of the tube; the ball-race is pressed against the nut by the forked lever. (See Figs. 44 and 42.) The top end of the tube is shouldered down to fit into the solid cone, but the distance of the shoulder above the ball-race must be ascertained by direct measurement.

To do this, fit the second forked lever on the $\frac{9}{16}$ in. shaft reasonably tight as usual to keep it in place while drilling for the tapered pin. It is to be at right-angles to the first one, and at such a distance along the shaft that the vertical clutch-rod will pass up centrally between the prongs of the fork. Remove the $\frac{9}{16}$ in. shaft complete with its levers; drill and broach the hole in the horizontal lever, and fit the pin. Re-assemble. Place the solid cone in the hollow one, and while holding it there, measure the distance from the bottom of the solid cone to the top of the fork of the horizontal lever when the governor balls are closed together. Subtract $\frac{3}{8}$ in. from this measurement, and that will be the length from the lower end of the tube to the shoulder at the top ($\frac{1}{4}$ in. for the ball-bearing plus $\frac{1}{8}$ in. for the part of the nut below the end of the tube). This would mean that the clutch cones would be tightly engaged when the governor was shut, with no room for it to open, and no room for the solid cone to withdraw from the hollow one. The required freedom will be provided by adjusting the nuts on the tube, using up, perhaps, $\frac{1}{16}$ in. of the $\frac{1}{8}$ in. which the nut projects.

I have said that the vertical shaft takes no part in the thrust on the cone, its job is to rotate it. Similarly, the tube takes no part in the rotation of the cone, it only pushes them together. A slot is cut in the tube, through both walls, below the shoulder, to allow a pin to pass through from the vertical shaft to impinge on another pin driven into the solid cone. (See Fig. 44.)

The pin in the shaft is tapered to fit a broached hole (say No. 28) and the smaller end of the pin impinges on the pin in the cone; it is, of course, threaded through tube and shaft when assembled together. The pin in the cone must be so planted that the shaft pin drives it clockwise when looking upwards. The slot in the tube must be long enough to allow ample clutch movement, and broad enough to allow the shaft pin to press against the cone pin when clear of the sides of the slot; let there be ample clearance.

If there was no cone pin, and the rotation of the clutch was transmitted from the shaft pin to the side of the slot, and so through the tube to the solid cone, it would cause great friction and binding, thus interfering with the freedom of the sliding action of the tube. By letting the shaft pin drive on the cone pin, that friction is eliminated. You can easily try the experiment by turning the tube half a revolution, so that the shaft pin projects 180 degrees from the cone pin, then holding the shaft in one hand and the tube in the other, exert torsion while moving the tube up and down on the shaft; then try doing the same with the shaft pin against the cone pin.

When the operation of winding is finished, the solid cone must be withdrawn. This is accomplished by the lead disc $2\frac{1}{2}$ in. diameter $\times$ $1\frac{1}{2}$ in. high, slipped over the tube to rest on the top nut. (See Fig. 44.) The lead should be turned smooth and bright, and immediately lacquered, as in the case of the main driving weight.

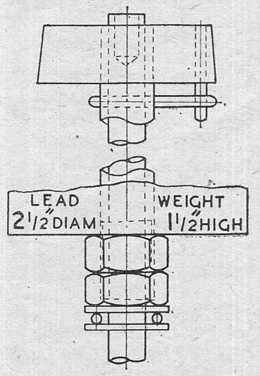


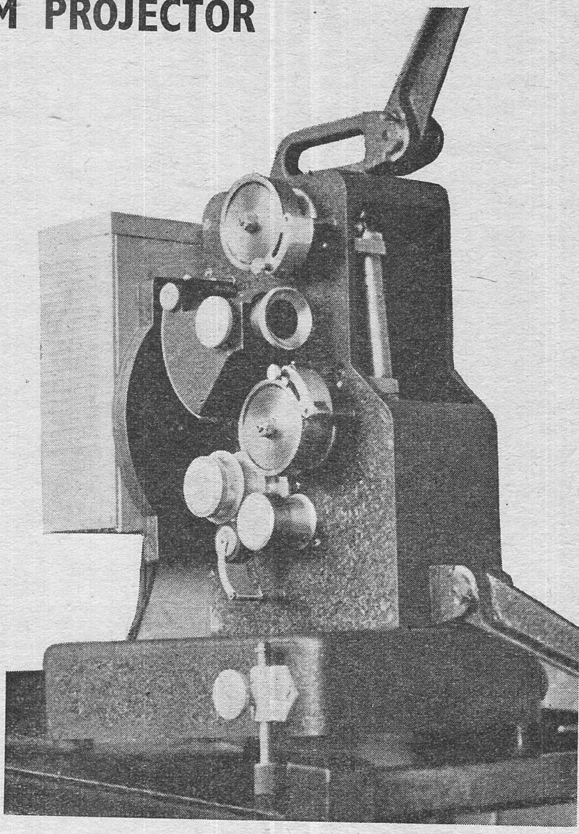
Fig. 44. Vertical shaft and clutch tube

Conclusion

Well, I think the operation of writing this series is also finished. Good luck to you all. My model locomotive "Como" appeared in the very first issue of THE MODEL ENGINEER, Vol. 1, No. 1, January, 1898, and here I am, still at it! A long innings. It would seem likely that only one other man has had such a long association with the Journal, and that is our mutual friend and benefactor, Percival Marshall.

16-mm. SOUND FILM PROJECTOR

By LESLIE A. SMITH



THIS projector was designed from experience gained from a 9.5-mm. silent machine converted to sound, some two years ago. Construction was started fifteen months ago in collaboration with a friend of mine, a Mr. Bernard Thorpe, and is entirely home-built, with the exception of the gears and lenses.

The main frame and base are built up from $\frac{1}{4}$-in. bakelised paper, which is remarkably strong and can be drilled and tapped with ease. The sprockets run on ball-races in aluminium housing, spigoted into the main frame, the spigots being turned 1/32 in. eccentric to housing, to obtain fine gear mesh adjustment. The backplate is cast aluminium, accommodating the totally-enclosed shutter, between condenser and gate. The lens mount, intermittent motion and gate are in one unit of cast aluminium, the intermittent shaft running in ball-races.

As can be seen by the photograph, the gate is curved and holds the film by the edges only, side tension being employed. The gate is turned from steel, in three sections; the outer member being fixed, the inner one spring loaded, the centre piece being movable vertically for framing by the small knob at top. The larger knob is for focusing, the spindle of which has an eccentric pin turned on the end, engaging in a slot in a sliding sleeve in lens mount. The lens barrel is a sliding fit in this sleeve. Coarse focusing is accomplished by sliding, and fine adjustment by the knob. Double-claw motion is used, employing a heart-shape cam working in a square frame, made from $\frac{1}{8}$-in. bakelised linen, carrying the hardened steel claws. The cam is case-hardened mild-steel.

There has been a lot of controversy of late in the correspondence columns of THE MODEL ENGINEER, *re* the merits of Maltese-cross versus claw movements, and from my experience, the claw motion is the steadiest and simplest for sub-standard work, and, if properly made and adjusted, will not damage a film.

I personally have run a brand-new 700-ft. copy through my projector some fifty times on tests, and there is not a sign of wear so far.

The cam was machined from mild-steel in a centre lathe, from a hand-made master cam, fifteen times bigger than the required cam size. The throw of the master cam was reduced fifteen times by a system of levers, the movement of which actuated the cutter the required amount, to cut the cam the desired size. The accuracy of the finished cam exceeded my expectations, it being within $\pm$0.001 in. on diameter, and within 0.0005 in. on throw, checked with a dial indicator.

The 25-tooth sprockets are machined from the solid in mild-steel, the teeth being cut with a form tool held sideways in the tool-post and advancing the saddle backwards and forwards, moving the top-slide a few thous. at a time, until the required depth of tooth was obtained. Dividing was achieved by a large disc mounted on the outer end of lathe mandrel, marked accurately with dividers into 25 divisions. Due to the large size of the disc, a big reduction in error was obtained.

The spool arms were cast in sand from aluminium, and fold down into front of machine when not in use. The arms, which are made to accommodate 1,600-ft. spools, are locked in the up or down position by a spring plunger.

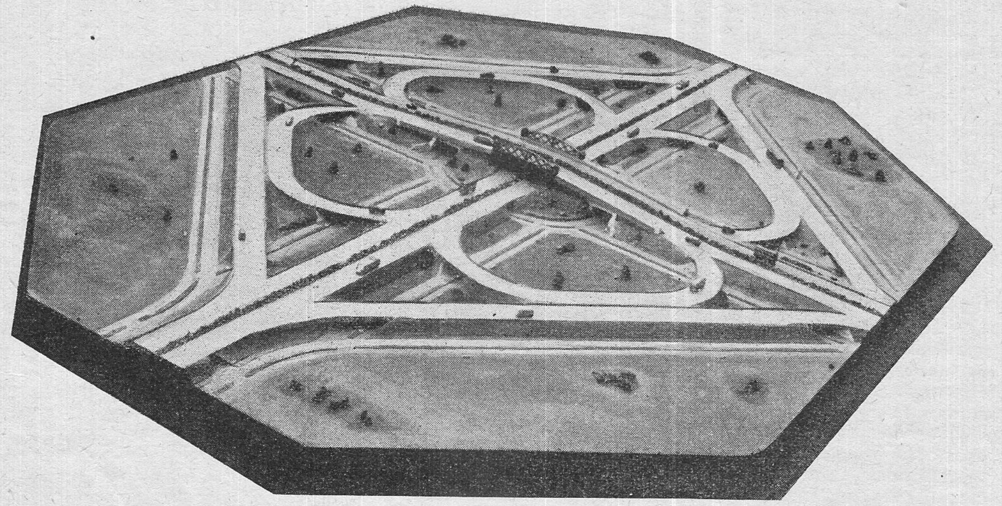
The scanning drum, seen immediately below the bottom (sound) sprocket, is of the rotating drum, flywheel type. The six-inch flywheel is mounted on the opposite end of drum shaft, and is totally enclosed between the main frames.

The photo-cell housing to the left of scanning drum is turned from aluminium and two flanges turned on this act as a guide to the film, prior to reaching the drum, which is without flanges. I have found from experience with the 9.5-mm.

(*Continued on page* 517)

"Clover-Leaf" Crossing

By HARLAND BROWNLESS



THIS model has been constructed for a Police "Safety First" exhibition, and, as far as I can say, it is the only "clover-leaf" model which has been made for public exhibition with separate footpaths and cycle-paths. The public and cyclists have been isolated entirely from all roadways on this crossing where mechanically-propelled vehicles are allowed.

I am a policeman, and I have been interested in modelling of all kinds for years; so, when a suggestion was made that the Traffic Branch, to which I belong, should provide an exhibit for the Yorkshire (W.R.) Safety Exhibition, a colleague of mine and myself got together and set to work. My colleague, who is very good with drawing instruments, drew the plan of this crossing. We found from the first that all road users would have to be catered for, as this crossing is a suggestion for safety on the post-war roads of this country. The only way to separate all types of traffic was to elevate the roadways above the foot- and cycle-paths.

After the drawing department had scaled things down satisfactorily, it was copied on to the base-board itself. The scale was 10 ft. to the inch, making the main roads at 22 ft. each with a 6-ft. dividing-strip, equal to 5 in. on the base-board. The subsidiary roads—that is, the loops from the main roads and the branch roads on the extreme outsides—each measure 22 ft. At this scale the crossing could be built in 300 yards square.

As to the construction, we had two ⅝-in. plywood boards 6 ft. 6 in. by 3 ft. 6 in., which made this model possible, and they were given to us by a gentleman who is very "safety-first"-minded. The width of the bridge section is 5 in., and a plank 5 in. wide was placed between the two boards. This layout comprised the full area of the crossing, and it was on this area that the plan form was traced.

After plans were complete, elevation was next considered. The height required was only that which would allow the passage of cyclists and pedestrians. This was put down to 12 ft. for the inside height of the bridges under the roadways. Bridges were marked where they would come on to the plan, and the height of the roads was maintained by appropriate pieces of wood laid under the roadway to bring the height of 12 ft. under the road bridges. The roads were made of Lloyd's hardboard. The looped roads were cut from the same material by a bandsaw. After elevation was complete and found to conform to the plan, the building was then started in earnest.

The hardboard was nailed down, where it was to stay, on to the small piles under it. At each side, a thin strip of sycamore was fastened to represent the wall at the edge of the road to a height of 2 ft. I am a great believer in sycamore for modelling. Thin strips of this wood, being so close-grained, can be bent without breaking.

This verge of 2 ft. high is continued all over the model, except at the bridges over the paths, which are brass rail soldered by their ends to two oval-headed nails sunk into the base-board. The grass banking was next built by another 1½-in. strip of sycamore laid from the roadway above to the base-board at a good angle. This method was continued throughout the model, except near the bridge and on the inside of the loops. All these curved sections were made rough at first by small pieces of sycamore, and the whole curves were covered by shaped pieces of roofing-felt.

Roofing-felt was also used on the high bankings under the bridge sides. This material so used can

be hammered into position, owing to its stiff qualities. Each board was built to match the others, and all parts which had to be "grassed" after the paths were drawn were given a good coat of glue, followed by a covering of fine sawdust. The texture of the sawdust was important, as, at the scale, the grass could easily be too high if not watched. The trees shown were made from pieces of loofah sponge and glued on. The small white marks are seats near the footpaths scaled down from 7 ft. to 1 ft.

I have left the bridge until last. This was of the bow-string type, and was built from a section of the curtain-rail previously mentioned. Altogether, there is 21 ft. of this brass rail on the model.

A jig was made for each side of the bridge, this being the pillars of the bridge to be used. Both these sides were pinned to a board next to each other, and I had a busy time with brass wire and soldering-irons, building this part; altogether, ten hours.

A height of 20 ft. was given under the bridge for vehicular traffic. I may say, at this point, that both outside boards with their edges carry the banking of the small roundabout under the bridge, and it will be realised there are three sections, the two boards and a separate centre bridge. The gradient of the bridge was controlled by the interior height and the distance of the four loops from the bridge centre. As one can see from the photograph, it worked out very well indeed, P.C. Pawley, of the drawing-office, having done his job. The tunnels under the bridge carrying the foot- and cycle-paths, were given the usual 12 ft. The centre bridge had for its first base a plank of pine 5 in. by 1½ in., for the roadway and tunnels; this was laid on another plank of the same material, 7 in. wide. The lower plank provided a step at each side of the bridge for the outside boards to rest on.

The centre strips dividing the foot- and cycle-paths are cardboard glued and sawdusted, and later painted green to represent grass.

All roadways were given a good coat of cellulose filler and finished with cellulous grey paint, matt finish. The underneath of all foot bridges was painted white.

All the vehicles on the plan were made by me from sycamore to scale. Radiators were made from gauze from the inside of radio valves, and small brilliants were used for head-lights. Altogether, twenty vehicles were made, representing the usual type of traffic seen.

The centre strip down the main roads was left until last. This was made of pieces of loofah and ordinary sponge, each piece separately glued on, to a scale height of 6 to 7 ft. This centre strip was placed down the main roads to prevent dazzle at night, and is suggested to be employed on any new post-war road.

The photograph was taken by a police photographer.

The model, upon being taken to pieces, has a separate box for the centre section and a large frame was made for both sides. They fitted into each side from the bottom, catches holding each side at the top.

I may say that a lot of the material used was scrap wood, and throughout we were without a proper work-bench or vice during its construction.

We are both rather surprised that, in Doncaster, where we reside, although it appears to be the home of steam, there appears to be no model engineering society.

16-mm. Sound Film Projector

(*Continued from page* 515)

outfit, that flanges on the drum itself have a tendency to make the film ride over the side. Guides prior to the drum eliminate this. The impedance roller, seen below cell housing, is rubber faced and mounted on a curved arm made from a section of a turned duralumin ring.

Adjustable spring tension is provided for this by a knob at rear of machine; this to be adjusted, while machine is running, to eliminate sound flutter, with the minimum of spring tension.

The optical unit (not fitted when picture was taken) is mounted immediately below scan drum, and employs a ¼-in. focus microscope objective and ⅜-in. focus condenser. A 0.0015-in. slit is used, which is reduced optically to 0.005-in. by a 3 : 1 reduction.

The exciter lamp of the 8-volt 32-watt type is housed in the base, running in series with a 50-volt 200-watt projector lamp.

I have been held up for a suitable motor. A 1/20-h.p. squirrel-cage induction was intended, but being unable to obtain one, I have acquired a 1/20-h.p. universal motor, and at the present am working on a suitable governor for this.

The lamp-house is made from 10-gauge aluminium plate with the cooling fins milled $\frac{1}{16}$ in. deep × ⅛ in. wide (representing a cooling area of 20 sq. in.), before bending to shape. The lamp-house cap was beaten round a wooden former from 18-gauge aluminium.

The gear layout is as follows: main shaft running in ball-races, carrying shutter, 1 : 1 skew gear to intermittent shaft, and 25 : 1 worm drive to sound sprocket. Top sprocket driven by 1 : 1 skew gear from sound sprocket, by vertical shaft seen in picture at front of machine with cover removed.

Drive from motor, fitted at far side of machine, is by rubber belt; one end of motor carrying cooling fan for lamp-house, opposite end carrying governor.

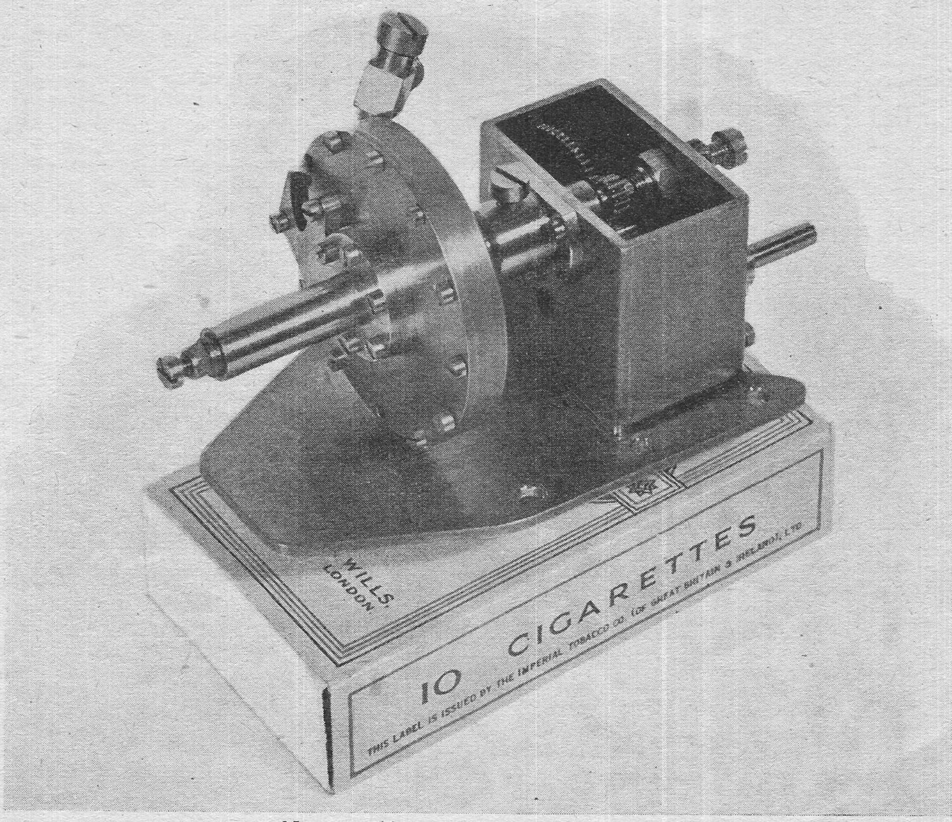
The amplifier is under way and employs a 6J7 H.F. pentode pre-amplifier stage, a 6N7 mixer and tone control stage, a 6N7 phase splitter in floating paraphase, into 2-PX4s. in Class A, push-pull.

The results with amplifier are good, and when I have traced the cause of a slight hum, the results should be excellent.

SMALL TURBINES

An appreciation and constructive criticism

By WALTER H. ELKIN



No. 2 turbine in its experimental stage

IN his recent series of articles on the efficiency of small turbines, Mr. J. H. Johnson has endeavoured to raise some enthusiasm in their development, enthusiasm which, in view of modern engineering practice, is sadly lacking. Being very interested in them myself and sharing his views, I wholeheartedly endorse his efforts to overcome the inertia of model engineers in this direction. It would appear that Mr. Johnson and myself have, unknown to each other, been working in parallel, covering much the same ground, even to the extent of preparing an article for eventual publication, and knowing the work involved in the digestion of advanced textbooks, the experimentation, and publication of results and conclusions, I would like to express my appreciation of his efforts which, reading between the lines, may have been carried out under certain difficulties. It is my belief that, because of possible experimental difficulties, he has drawn erroneous conclusions; they are in fact, completely opposed to mine and as progress is never achieved without criticism, constructive criticism that is, my own views, based upon results so far obtained, will no doubt be of interest to Mr. Johnson and to others who may be sufficiently roused to attempt what has been to me a most fascinating sphere of model engineering. Perhaps it would be better to call this a comparison of points of view where differences occur; criticism is too hard a word to apply to work which has so obviously been carried out in such a scientific manner.

Dealing with these differing points of view as they arise and numbering them in orderly fashion, we have :—

1. The Sub-title: "Can progress be made by reversion to low-pressure steam?"

The whole history and future progress of steam engineering is based upon the use of increasingly higher pressures and correspondingly larger temperature range over which the steam may be expanded. The greater this range the higher the

efficiency, as friend Carnot taught many years ago, and this applies to all heat engines, whatever their size, type, or working fluid. The limitations of Carnot's cycle of operations are mainly physical and the small turbine provides an excellent example of this and also of the refusal of Dame Nature to be scaled. The velocity of steam issuing from a hole 1 in. in diameter is just the same as that from a hole ten times or more larger; the difficulty is to keep up with it. Working at low pressures in an attempt to slow it up is one point of view, the other, and, to my mind, more rational way of looking at it, is to overcome the physical limitations imposed by the high steam velocity and let your turbine wheel run at an appropriate speed necessary for a reasonably high efficiency.

2. Departures from accepted theory.

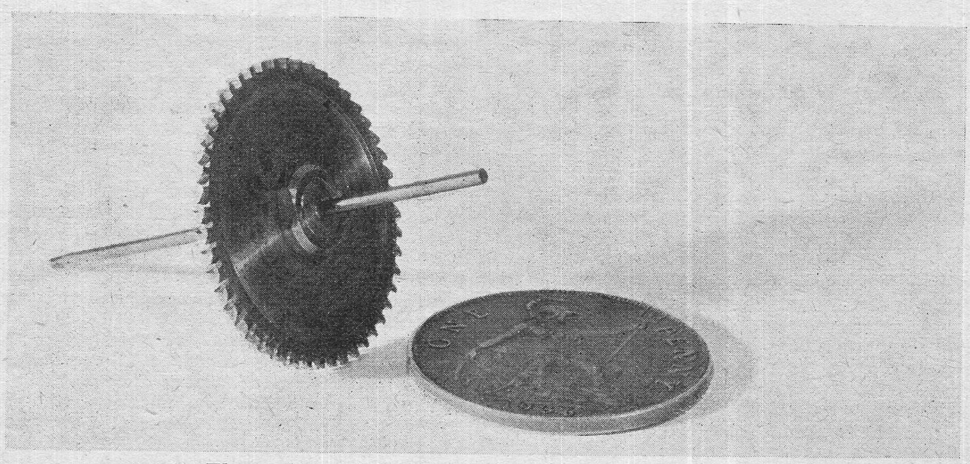
I fail to see any reason why the small turbine should be treated any differently than the full-sized article, or why it should be any the less efficient in proportion when designed as such. My No. 2 turbine has been so treated and, as will be seen shortly, the proportions of its essential parts are as those of a full-sized machine. In spite of the fact that I have done practically everything Mr. Johnson says I must not do, the results so far obtained would appear to justify the method. It is well known that "L.B.S.C." obtains more pounds pull per adhesive pound at his drawbar than does "Big Sister" and Mr. E. T. Westbury more horsepower per litre than "Big Brother." Why should I not obtain greater power in proportion to unit weight or volume when compared with a reciprocating engine of similar steam consumption?

3. Velocity diagrams and maths. in general.

To anyone breaking new ground, the appropriate tools are desirable though not absolutely necessary (acknowledgment to "L.B.S.C.") and as little information is available, one has to go to the reference and textbooks in order to quench one's thirst for knowledge. The results of these investigations into the realm of higher maths. varies, and we all adopt our own little wangles towards the desired end, the wangle in particular being the method of subtracting half the blade speed from the vector representing the relative inlet velocity in order to determine the magnitude of the outlet vector. The more normal way is to multiply the inlet vector by a co-efficient that has been established during many years past and usually has a value of 0.85 for an impulse blade. It will be seen that in Table 1, the estimated losses are based upon a nozzle efficiency of 0.9. This is far too high, as will be seen later, and has led to an incorrect energy balance, particularly as to that available at the shaft. Unfortunately, there is no indication as to whether these figures have been attained in practice, the only actual speed figure ever mentioned being 7,500 r.p.m. with a 2-in. diameter wheel. Forgive my quoting figures the significance of which may not be obvious to anyone knowing little of turbines, and I must ask you to believe them, and me, when I say I am not trying to "cook" them. To resume, at this speed the energy at the wheel-rim will be only 3.91 ft./lb., as the stage or wheel efficiency is only 10 per cent. Subtract from this the windage, friction, and gear losses, and what have you? Considerably less than the 8.98 ft./lb. quoted. This leads me to believe that the curves published, like Table 1, are what Mr. Johnson hopes will happen.

4. Nozzles.

In order to save myself a great deal of trouble, I took even more to produce a set of curves giving nozzle sizes with respect to different boiler pressures and steaming capacities, purely theoretical, of course, but as far as they have been used, the discrepancies between theory and practice seem to be fairly small. One would expect, because of frictional losses, that the diameter would need to be larger than indicated. Queerly enough, it needs to be a few per cent. smaller. It would be nice to assume that the efficiency was the same as full-sized ones, but it is not safe to do so, and tests were made to measure the actual steam velocity which theory says should be 2,450 ft. per second when expanded from 60 lb. per sq. in. The highest figure recorded was 900 ft. per second, but this result is masked by peculiar behaviour of the impulse plate, due to entrainment and circulation of air and dead steam, and it is known to be somewhat higher than this,



The unshrouded rotor and shaft compared with a penny

more like 1,200 ft. per second, i.e., a nozzle efficiency of 50 per cent. This means that only one quarter of the potential steam energy is available and is one reason for the inefficiency of small turbines.

As to the number of nozzles required, only under unusual circumstances should more than one be necessary. With the largest boilers likely to be encountered working at normal "model" pressures, the outlet of a single nozzle will rarely exceed $\frac{1}{16}$ in. in diameter, which is small enough anyway, without using a number of even smaller, and, from the foregoing remarks, is most likely to have a higher efficiency. The fact that it works on only one blade at a time is not significant. For a given weight of steam, the total turning moment on the rotor is the same, whether all the steam is blowing on one blade, or half of it on two, or 1/nth of it on n blades.

5. Rotors.

Quite a large amount of space has been devoted to the losses caused by rotor windage and an admirable attempt made to resolve them. Unfortunately, they only exist as the result of a loss of the sense of proportion that seems to afflict all designers and constructors without exception. Building rotors too large and blades even larger, resulting in unreasonably high losses, and the apparent fear of speeds in excess of 10,000 r.p.m. is the very reason for stagnation. After all, if the 30-in. diameter rotor of a 300-h.p. turbine rotates at 10,000 r.p.m., one of 1 in. diameter must do 300,000 r.p.m. for equivalent efficiency! It is not quite as bad as this, as the steam velocity will not be as high.

It is a strange thing to me that the blades are always made so large. An average nozzle outlet is of the order of 0.04 in. in diameter and there is no reason why the blade height should exceed this by more than about 25 per cent., or why its width should be any greater than this. Steam, having issued from a nozzle, begins to slow up as its volume increases and its direction must be reversed to obtain the driving force before any significant drop in velocity occurs, particularly as its energy is a function of the square of the velocity. This seems to indicate a narrow blade as close to the nozzle as possible and is far more important than any consideration of what happens to the dead steam afterwards. Steam is a gas and its particles have no finite size, and a narrow blade with the correct curvature is more effective than a wider one; it is not as if one were considering what might be termed a hail of small ball-bearings issuing from a nozzle.

Success will follow when constructors realise that blading a small wheel is "watchworks," to pinch a phrase of a well-known man, and when speeds of the order of 50,000 to 100,000 r.p.m. can be contemplated with equanimity and without visible staggering. Quite an elementary calculation will show that a shaft of 0.063 in. in diameter revolving at 100,000 r.p.m. in a bearing, is doing so under much better conditions than exist, for instance, in an ordinary car engine. As to the weight of the rotor, as light as possible. Useful energy at the shaft is the requirement, not useless kinetic energy stored in the wheel. Finish—a high polish, if possible, and definitely no projecting excrescences, and above all, truth, concentricity, and perfect balance. None of the rotors shown in the last instalment are capable of attaining a really high speed, and this has led Mr. Johnson to believe he can increase his apparent efficiency by reducing his steam pressure. The one labelled *F*, incidentally, is precisely the same size (4 in. diameter) as that used in a full-sized de Laval turbine of 5 h.p., wherein it runs at 30,000 r.p.m. That is what I mean by sense of proportion.

6. Gears.

It is obvious that these will be a problem all on their own. All I can say is that their quality must be high and that I have had good results by wrecking a good quality French clock movement of the type usually seen in marble cases. One that has "had it," of course!

7. Conclusions.

Most of the points which arise here have already been dealt with, but in (*a*) is a contradiction. If the use of a condenser means saving the steam for further use, all well and good, but if it means exhausting at a pressure below atmospheric, then the whole object of low steam velocities is defeated. Reference to steam tables will show that there is a surprising amount of energy in sub-atmospheric steam. The velocity depends more upon the expansion ratio than upon its absolute pressure, and the reason for the use of a number of low-heat drop stages in a "pressure compounded" machine is that of limiting steam velocities.

Justification

I am not in the habit of making statements without due consideration, and though the foregoing may at times appear somewhat swe p ing they are not made without a certain amount of backing based upon results, and I will quote the performance of my No. 2 turbine as justification. In the design stage it was treated just as if it were a full-sized machine, using full-sized coefficients for the nozzle and blades, and its essential proportions scaled down from a sectional illustration of a 15 h.p. de Laval machine in "Steam Turbines," by Dr. W. J. Goudie, which, together with "Steam Turbine Theory and Practice," by Dr. W. J. Kearton, have been the sources of my design information.

The nozzle, designed to expand 1 oz. of steam per minute from 60 lb. per sq. in. to atmosphere, has a throat diameter of 0.022 in. and its outlet diameter 0.028 in., the length being 0.057 in., with a divergent taper of 6 deg. The rotor, shown in the illustration with a penny for comparison, is 1.2 in. mean diameter, 0.064 in. thick at the rim, and has 48 blades of correct profile shape milled 0.04 in. deep into its edge, this little job being done with the aid of a pantographic engraving machine and much holding of the breath. It is mounted centrally on a hardened silver-steel shaft 0.063 in. diameter, nearly 2 in. long, which runs in bronze bearings at its ends. These bearings are supported in extension bosses on the main casing in which the wheel rotates with a clearance of 0.015 in. all round. A small pinion, a taper-fit on one end of the shaft, forms the first wheel of a compound reduction gear of 18-1 ratio, the size of the whole thing being such that it sits comfortably upon a packet of ten cigarettes.

Having been built at a time when experience at high speeds was limited, the rotor was designed to run at the comparatively modest speed of 54,000 r.p.m., giving an output speed of 3,000 r.p.m., a very convenient figure for stroboscopic determination on 50-cycle a.c. mains. As a consequence of this comparatively low speed, and assuming for a moment a nozzle coefficient of 0.9, the blade/steam ratio has the low figure of 0.128, the corresponding wheel or stage efficiency being 37.5 per cent. Still assuming a nozzle coefficient of 0.9, the energy available in the steam would be 0.143 h.p. and 37.5 per cent. of this, or 0.054 h.p., would be obtained at the wheel rim, but would be reduced by friction and gear losses.

Because the nozzle coefficient is only about 0.5 and the steam energy is proportional to the square of the "inefficiency," this energy is only about one-quarter, or 0.036 h.p., but the blade/steam ratio is now 0.225 and the stage efficiency has risen to 62 per cent., with a corresponding rim energy of 0.022 h.p. From the fact that the wheel does nearly twice the speed running light (measured), it is fair to assume a mechanical efficiency of 50 per cent. Thus the output should be 0.011 h.p. Note the figure.

Returning to the turbine, it was sufficiently near completion to undergo its initial steam test, and driving only a cyclometer-type counter it registered 89,000 r.p.m. on 55 lb. of steam. This, by the way, without its blade shrouding. This is where the trouble started, and subsequent attempts to measure its output failed because of the impossibility of persuading it to run above its critical speed of 27,000 r.p.m. due to excessive unbalance after fitting the shroud, and more than a month has been spent in searching for the cause of this behaviour and during which the 89,000 r.p.m. was gravely suspect and I was side-tracked into attempting to measure steam velocities. The rotor balance must be practically perfect. However, it was managed at last, and the wheel reached a speed of 106,800 r.p.m. running light! It was now possible to measure the output on a friction brake rigged for the purpose, the result being 0.113 h.p. at 54,000 r.p.m. This is in very close agreement with the predicted figure of 0.011 h.p. and shows that the actual nozzle coefficient and/or the mechanical efficiency is higher than assumed. This is a very gratifying result, which I have no doubt can be improved upon in the light of further knowledge to be gained from a projected investigation into the properties of nozzles, and it is known that the blade inlet angle is too small and can be improved upon.

Before concluding, it would be desirable to draw a comparison with a reciprocating engine under similar conditions of speed and steam consumption. I have searched back numbers of THE MODEL ENGINEER up to three years old, but of all the engines described none appears to produce any horsepower, only Mr. Johnson's turbine, and that is measured in "S.T." units, a peculiar lapse on his part, considering the trouble he has taken otherwise. However, I have found something in the pre-war catalogue of a very well-known firm of model engineers, whose excellent products will soon be with us once more, it is hoped. Here it is stated that a very popular twin-cylinder engine of similar consumption produces, when driving a dynamo of their manufacture, an output of 4 watts, i.e., 0.0053 h.p. Being fair and having some knowledge of small electrical machinery, let a dynamo efficiency of 30 per cent. be assumed. This will make the engine output 0.016—sufficiently close to my turbine to make me hope I can exceed it.

Thus, I now have a power unit which, when compared with a particular reciprocating engine, gives a similar output, is three times lighter and occupies but one-fifth of the volume. Moreover, it has a very even and constant turning moment and one advantage that will never be possessed by its confière. If for any reason it is desired to increase the output, instead of building another engine, all that is necessary is to fit a larger nozzle to pass the required amount of extra steam.

In concluding, I would like to add that my reason for writing this is to disclose the fact that Mr. Johnson's is not the only voice crying in the wilderness and to give a brief glimpse into my activities, which are directed to increasing the popularity of the small impulse turbine, and to which end I have, and will continue, to devote a large portion of my spare time in determining the best methods of design and construction. The results of this work will eventually be made available in a simplified form which will enable intending constructors to build small turbines with a performance that could be almost guaranteed.

Clubs

Cardiff and District S.M.E.E.

A very full programme was got through on the evening of Wednesday, April 17th, commencing with the long-awaited presidential address by Mr. E. Jones, the City's electrical engineer, who is now fully recovered from his recent illness.

This was followed by a lecture by Mr. Morris, on an experimental forced-induction two-stroke engine, of his own design, and, as always, he put across some really entertaining material. Unfortunately, we are to lose Mr. Morris and he will be missed by all and sundry.

Meetings—1st and 3rd Wednesdays each month.

Hon. Secretary: F. B. ANGWIN, 47, Rommilly Crescent, Canton, Cardiff.

Mansfield and Sutton-in-Ashfield S.M.E.E.

The usual weekly meetings of the above Society are now held in the workshop in Bowne Street, Sutton-in-Ashfield, at 7.30 p.m. The workshop is now being fitted up in readiness for commencing work on two Society locomotives, one to be a "Midge"-type engine. There will be an Atlas 5-in., a Myford 3½-in., and a Willimott 3¾-in. lathe installed shortly; also, a five-speed motorised "Progress" bench-drilling-machine, which will get things moving, as well as the usual small tools and vices, with probably a Willimott milling-machine. Hon. Secretary: J. CORBETT, "Lathes," Stanton Hill, Nr. Mansfield, Notts. *Telephone*: 583 Sutton-in-Ashfield.

Society of Model and Experimental Engineers

There will be a meeting at 39, Victoria Street, Westminster, S.W.1, on Saturday, June 15th, at 2.30 p.m., when Mr. F. S. Lovick-Johnson, M.I.Loco.E., will give a talk on the "Merchant Navy" class locomotive. A number of interesting slides are promised to illustrate this talk.

Full particulars of the Society may be obtained from the Secretary: J. J. PACEY, 69, Chandos Avenue, Whetstone, N.20.

Slough and District Society of Model Engineers

The above Society, inaugurated in July of last year, is now well established, with over 60 members, lectures, live steam meetings, and monthly work competitions being well attended; the lecture on the design of small locomotives, by Mr. Maskelyne, being especially appreciated.

On Monday, April 29th, Mr. W. G. Kyte gave a most interesting talk on Intricate Mechanisms. The Society meets in the canteen of Messrs. McMichaels Ltd., Wexham Road, Slough, and future meetings are booked as follow:—May 27th, Model Ship Construction, Mr. H. O. Danckwerts; June 17th, Some Applications of Radio, Mr. E. J. Lambert. A hearty invitation is extended to interested visitors.

In August, the Society will run a model railway track, 2½-in., 3½-in., and 5-in. gauge, for a week, in aid of the local hospitals, and the Track Secretary, Mr. H. W. E. Varney, 21, Aldborough Spur, Slough, will welcome a word from owners of locomotives willing to run their passenger-hauling engines for part of this period. Mr. Varney will advise further details on application.

May we add that a great part of the success of the Society has resulted from the guidance given by Mr. Marshall and Mr. Maskelyne, of THE MODEL ENGINEER, at the commencement of last year.

Hon. Secretary: W. F. HUNT, "Gleneagles," 259, Stoke Road, Slough.

South London Model Engineering Society

The next meeting of the South London Model Engineering Society will be held on Sunday, June 9th, at Kings' College Sports Ground, Dog Kennel Hill, East Dulwich, at 11 a.m., and will be a Brains' Trust, Mr. T. Rowland in the chair, supported by Messrs. Davidson, Baxter, Physick and Wright.

We are pleased to be able to report that the L.C.C. have now granted permission to the Society for the use of the Brockwell Park lake, Herne Hill; unattached South London readers should make a special note of this and get into touch with the secretary; full particulars of the opening meet will be announced shortly.

Although the weather was more than inclement on Sunday, April 28th, when the Society held its field-day at Downs Lane, Leatherhead, all had a thoroughly enjoyable time, representatives from the clubs at Sutton, Dorking, Leatherhead, Croydon, Staines and Sidcup attended, many locomotives and a traction engine and stationary engines being under steam.

Mr. J. C. Crebbin, one of our vice-presidents, who took the chair at the sit-down tea, entertained us with reminiscences of his experiences from his wide and very full model engineering activities. Closing his remarks, he paid a very graceful compliment to Mrs. Cunningham and her willing band of ladies for the feast.

The date will be announced shortly for the best locomotive performance trials, when the Crebbin prize will be awarded and when other clubs will be invited to compete.

Hon. Secretary: W. R. COOK, 103, Engleheart Road, Catford, S.E.6.

Lincoln Model Engineering Club

A visit was paid to the pumping station of the water department of Lincoln Corporation, at Elkesley, on Saturday, April 27th, through the kind permission of Mr. Donald Whiteley, M.A., engineer and manager.

The party was conducted over the station by the station engineer, Mr. Bell, who proved a most instructive and interesting guide, commencing as he did from the source of the water at the bore-holes through the settling tanks to the mains. The two large marine-type triple-expansion engines were a source of great interest, as also were the various electrical recording instruments, indicating the level of water in the reservoir twenty-five miles away in the City of Lincoln. The recently installed electrically-driven bore-hole pumps were, of course, of great interest to the electrical enthusiasts.

Some slight progress is being made in connection with the track for locomotive enthusiasts.

Hon. Secretary: GEO. T. SINDALL, 53, Geneva Avenue, Lincoln.

Coventry Society of Model and Experimental Engineers

Members of the above Society are to be given an opportunity to air their knowledge on subjects within the scope of model engineering at the "Quiz Night," May 24th, 6.45 p.m.

An Electrical Apparatus Discussion on June 7th, 6.45 p.m., should provide enlightenment to members whose knowledge of this subject is limited, and it is requested that the experts, in particular, should attend to contribute to the enlightenment.

Hon. Secretary: J. F. BACK, 3, Macaulay Road, Stoke, Coventry.

Leicester Society of Model Engineers

The next meeting will be held at 7.0 p.m., Tuesday, May 28th, in the canteen, The Precision Engineering Works, Wellington Street. This will be an open night, when members' problems and pieces of work will be the main features.

Hon. Secretary: J. WALKER, 78, Waltham Avenue, Leicester.

NOTICES

The Editor invites correspondence and original contributions on all small power engineering and electrical subjects, which should be addressed to him at 23, Great Queen Street, London, W.C.2. Matter intended for publication should be clearly written, and should invariably bear the sender's name and address.

Readers desiring to see the Editor personally can only do so by making an appointment in advance.

All correspondence relating to sales of the paper and books to be addressed to THE SALES MANAGER, Percival Marshall and Co. Ltd., 23, Great Queen Street, London, W.C.2.

Correspondence relating to display advertisements to be addressed to THE ADVERTISEMENT MANAGER, "The Model Engineer," 23, Great Queen Street, London, W.C.2.

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Wanted, Vertical Slide, "A" size Split Chucks, and any accessories or parts for "2½ G.A." lathe.—JAS. TOPPING, 13, Lilybank Gardens, Glasgow, W.2.

This Week's Model Engineers' Bargains—2 Horizontal Steam Mill Engines, £5 each; Railway Engine and Tender, £10. First letter opened with cash secures.—NUTTALL'S (LATHES) LTD., Mansfield.

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Workshop Clearance, 7" Forge Fan, 2" pipe, £3; boiler test pump with 500 lb. gauge, £8; Evinrude 2 h.p. Engine, with flywheel, bronze shaft and propeller, £5; Stuart Vertical, 2½" bore, 2" stroke, with Fulmen 30 volt dynamo, casting and combined bedplate, £8; bronze outboard gear with propeller, clips on transome, suit punt, £4; 5 c.c. Kestrel for boat, £3; pair Canoe Paddles, 30s.; 4 h.p. Douglas Engine, make good compressor, 50s. All goods carriage extra.—IRVING, Rawcroft, Penrith.

All Brand New Swiss Needle Files, 1s. each; 9s. dozen assorted; £5 gross; Oilite Bearings, ⅜", 4d.; ½", 6d. each; 6" Circular Saws, 9s. each; Lathe Carriers, ⅜", 1s. 6d.; ⅝", 1s. 9d. each; small Angle Plates, 3s. each; postage 3d. Reduction quantities. Adept sales and service. Lists, stamp.—N.R.B., 473, Abbeydale Road, Sheffield.

Pratt 4" Self-centring Chuck, new, £2 10s.; ¼ Jacobs Chuck, 10s. 6d. S.A.E. for list.—4, Rosslyn Avenue, Rutherglen.

Wanted, 3½" Drummond or Similar, Tools and accessories, also Milling Machine. High price paid for good condition, or exchange Zeiss 16 mm. projector and Kodak Ciné Camera, value £110. Also wanted MODEL ENGINEERS, 1939 to date.—NIXON, 17, Quantock Avenue, Bridgwater.

2" Centre Bench Precision Screwcutting Lathe, complete, 12" between centres, equipped with 3" S.C. Chuck, Faceplate and 1 set of Collets with draw-in bar (hollow mandrel), almost new condition, for sale at—282, Kingsland Road, London, E.8.

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For Sale, 5" IXL Lathe, S.C., self-sliding, surfacing, faceplate, 6" 3-jaw S.C., 6" 4-jaw Independent, and Tail-stock Chucks, Centres, Tools, Micrometers, etc., complete with countershaft on standards, 1 h.p. A.C. Motor, with mains switch, push button starter, £50 the lot.—F. THODY, London Road, Knebworth, Herts.

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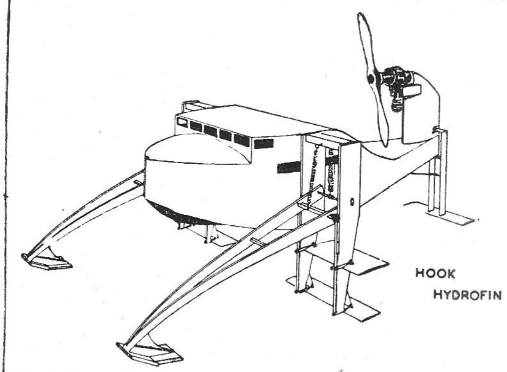
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